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MODEL 360

Vibration Spectrum Analyzer/Balancer

OPERATION MANUAL

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MODEL 360

Vibration Spectrum Analyzer/Balancer

OPERATION MANUAL

IRD Mechanalysis, Inc.
Subsidiary of H. H. Robertson Company
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Columbus, Ohio 43229
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This Contract shall be governed and construed in accordance with Ohio, USA Law.

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TABLE OF CONTENTS

	Page
Introduction	1
Description	2
Preparation Procedure	16
Operation:	
Balance Mode	18
Track Mode	28
Spectrum Analysis Mode	30
Overall Vibration Mode	33
Sound Measurement	34
Applications:	
Application of Model 360 for Spectrum Analysis	36
Application of Model 360 for Detecting Machine Criticals & Natural Frequencies	42
Application of Model 360 for Measuring Dynamic Response and Mode Shape of Structures	45
Use of Model 360 for Overall Vibration vs. Speed Measurements	49
Specifications:	
Model 360	51
Model 544 Vibration Pickup	56
Model 910 Vibration Pickup	58
Cables for Model 910	60
Insulated Mounting Studs for Model 910	62
Magnetic Accelerometer Holder for Model 910	63
Addendum:	
Reference Pickup Installation	64
Model 544 Vibration Pickup, Attachment Methods	74
Model 910 Vibration (Accelerometer) Pickup Attachment Methods	78
Calibration Check Procedure	80
Input Multiplier Null Procedure	82
Use of Self-Powered Strob Light and External Oscillator	84
Specifications - Model SP585 Strob Light	88
AUTHORIZED SERVICING AGENCIES	90

INTRODUCTION

Conditions in a machine that eventually result in breakdown and extensive repairs can be detected by the vibration they cause. An increase in the severity of such mechanical troubles is revealed by increased vibration. These vibrations are often complex and require a capability to separate one from the other if the trouble is to be found. The IRD Model 360 Vibration Spectrum Analyzer/Balancer not only has this capability, but is equally suited for in-place dynamic balancing with remote phase indication. It can analyze vibration even when machine speed is varying.

This manual is written to provide you with the understanding of how the instrument is operated. For details on its application, IRD MECHANALYSIS, INC. has available a comprehensive training program which covers vibration measurement, analysis, identification and dynamic balancing. Using the latest techniques, the Mechanalysis Audio-Visual Training Program is conducted in principal cities throughout the U.S.A., Canada, Western Europe, United Kingdom and South Africa, at no charge to you. For details contact your nearest IRD MECHANALYSIS, INC. office.

DESCRIPTION

The IRD Mechanalysis Model 360 Vibration Spectrum Analyzer/ Balancer is an extremely versatile, portable unit to perform automatic analysis of vibration and noise on steam and gas turbines, compressors, pumps, gears, motors and other rotating machines.

The Model 360 combines the capabilities of:

1. Narrow Band Spectrum Analysis: Provides a signature of machinery noise and vibration by automatic electronic filter scanning with built-in provisions to provide all necessary signals for operating an XY recorder.

2. Automatic Tracking Filter: Provides a plot and permanent record of vibration amplitude and phase over a wide speed range for detection of resonances, critical speeds, mode shapes, etc.

3. Precision, in-place dynamic balancing utilizing a unique tracking filter and remote phase indicating meter.

The Model 360 represents a revolutionary advancement in measurement instrumentation and is an ideal unit for field and test cell application. Some of its outstanding features include:

PORTABILITY

The Model 360 is lightweight and weighs only 29 pounds. The instrument and accessories, in its carrying case, can be stowed under an airline seat.

VERSATILITY

The Model 360 accepts inputs from a wide variety of transducers - velocity pickups, accelerometers, non-contact pickups, microphones and torsiographs. Inputs are read directly on the amplitude meter in either mils (pk-pk), in/sec (pk), or Sound Pressure Level (dB) over a wide dynamic range.

RELIABILITY

The Model 360 utilizes the latest integrated circuitry plus techniques proven to be highly reliable under rugged field conditions and quality control testing. The unit is housed in a splash-proof, moisture resistant case.

RUGGEDNESS

The Model 360's ruggedness is insured by its sturdy seamless case with "O" ring seal between upper and lower portions. Protection of the electronics against shocks and vibration is accomplished with rubber guards attached to the outside of the case.

RAPID SETUP TIME

The Model 360, being a single unit, requires a minimum of cable connections for operational setup. Further, cable connections are up front where they are readily accessible and visible. Sensitivity dials allow the output of the transducer selected to be read directly in the proper dimensions (e.g., mils pk-pk) from the unit's meters or on the XY recorder. No computation is required to correct readings for various transducer's sensitivities.

CLARITY OF DATA PRESENTATION

For in-place balancing, the Model 360 provides a simultaneous display of vibration amplitude, shaft speed, and phase on three meters. The phase reading is continuous without any ambiguity near 0° and can be easily read to within 2°.

For spectrum analysis, a permanent record of the vibration amplitude vs. frequency is produced automatically by an XY recorder with either linear or logarithmic amplitude scale as required.

In the tracking mode, a similar permanent record of vibration amplitude and phase vs. machine speed is generated on an XY_1Y_2 recorder.

For ease of recording, these operational features are built-in on the Model 360:

- Automatic pen lift
- Recorder Calibrate - Zero/Full Scale
- Min-Max frequency limit controls permit detailed rapid scan of any selected portion of frequency range

SHARP FILTERING

The Model 360's constant bandwidth filters provide narrow bandwidth analysis to achieve the best possible frequency resolution in the minimum amount of time.

RAPID DATA ACQUISITION

In the spectrum analysis mode the Model 360 provides fast sweep on each frequency range optimized for rapid data acquisition.

OVERLOAD LIGHT

The overload light provides a warning of inaccurate readings whenever excessive background vibration signals cannot be filtered out, even though amplitude meter indication is less than full scale.

DETAILED DESCRIPTION

FRONT PANEL (Figure 1)

The 360 front panel is arranged according to functions for convenience of operation. The left side of the panel contains the AMPLITUDE METER, AMPLITUDE RANGE SELECTOR, and PICKUP SELECTOR.

The center of the panel contains the MIN-MAX FREQ SWEEP CONTROLS, OVERLOAD INDICATOR, MANUAL TUNING CONTROL, FREQUENCY METER, FREQUENCY RANGE SELECTOR, PHASE SCALE INDICATORS, PHASE ADJUST CONTROL, and REFERENCE (level) ADJUST CONTROL.

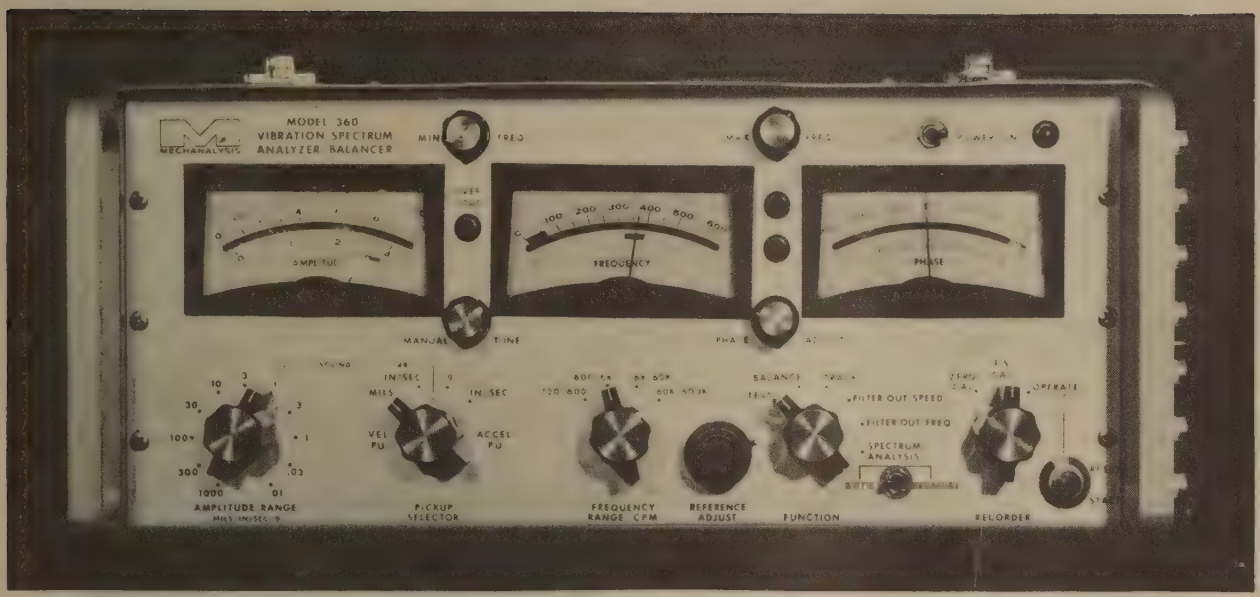


Figure 1. Model 360 Front Panel

The right side of the panel contains the POWER OFF-ON SELECTOR and INDICATOR, PHASE METER, FUNCTION SELECTOR, AUTOMATIC SWEEP or MANUAL TUNING SELECTOR, RECORDER SELECTOR, and RESET/START SELECTOR.

AMPLITUDE METER

The AMPLITUDE METER indicates the vibration amplitude. It indicates displacement in mils (one mil = .001" peak-to-peak), the velocity in inches per second peak, and acceleration in peak g's on the two linear scales, 0 to 1 and 0 to 3. The scale used is determined by the position of the AMPLITUDE RANGE SELECTOR.

Sound pressure level is read on the -5 to +10 dB scale. (Requires a Model 308 Sound Level Meter accessory.)

The green "TEST" area of the AMPLITUDE METER is used in conjunction with the TEST position of the FUNCTION SELECTOR to check the instrument for proper operation.

AMPLITUDE RANGE SELECTOR

The AMPLITUDE RANGE SELECTOR determines the full-scale meter range of the AMPLITUDE METER. Vibration amplitude, peak-to-peak displacement, is indicated in mils (1 mil = 0.001 inch). Velocity is indicated in inches per second peak. Acceleration is indicated in peak g's. Sound pressure level (SPL) is indicated in dB. Full scale amplitudes from .01 to 1000 mils, inches per second or peak g's are covered in eleven ranges. Positions marked 1000, 100, 10, 1, .1 and .01 are used with the 0 to 1 scale. Positions marked 300, 30, 3, .3, and .03 are used with the 0 to 3 scale. SPL is read on the -5 to +10 dB scale. Position of the AMPLITUDE RANGE selector indicates the full scale range of the AMPLITUDE METER for that setting (linear scales). See Page 51 for metric ranges.

For instruments measuring vibration amplitude in metric units, peak-to-peak displacement is indicated in microns, peak velocity is indicated in millimeters per second, and peak acceleration in g's.

The TEST position on the FUNCTION SELECTOR is used in conjunction with the green "TEST" area of the AMPLITUDE and FREQUENCY METERS to check the instrument for proper operation. See "Circuit Operation Check" in the section PREPARATION PROCEDURE.

PICKUP SELECTOR

Either the displacement (MILS peak-to-peak) or the velocity (IN/SEC pk) of the vibration from the velocity pickup may be chosen for measurement by the PICKUP SELECTOR. Either the velocity (IN/SEC pk) or acceleration (g pk) of the vibration from the accelerometer pickup may be chosen for measurement by the PICKUP SELECTOR.

OVERLOAD INDICATOR

The amber OVERLOAD INDICATOR is illuminated when a large vibration outside the bandpass of the synchronous filter overloads the filter to the point of decreasing the accuracy of amplitude and phase meter readings. Since the large vibration is outside the filter's response, it is not evident in the amplitude meter reading. The overload condition would be obvious in the FILTER-OUT position because the meter would be over full scale. If a steady overload condition is observed, a larger full scale range of the AMPLITUDE RANGE SELECTOR must be selected. If the overload indicator is only flickering, the amplitude and phase readings are not seriously affected.

REFERENCE ADJUST CONTROL

The REFERENCE (level) ADJUST CONTROL circuit of the Model 360 provides a means of adjusting the reference signal level for best triggering to compensate for (1) variances in the outputs of different types of reference pickups, (2) noise or other inherent factors affecting the periodic input signal, and (3) problems or errors in preparing the reference pickup triggering surface. A ten turn dial makes possible precise logging of reference level.

FREQUENCY RANGE SELECTOR

The frequency meter range and the synchronous filter frequency range in cycles per minute (CPM) are determined by the FREQUENCY RANGE SELECTOR setting. There are four ranges: 120 CPM to 600 CPM (2 to 10 Hz); 600 CPM to 6000 CPM (10 to 100 Hz); 6000 CPM to 60,000 CPM (100 to 1000 Hz); 60,000 CPM to 600,000 CPM (1000 to 10K Hz).

FREQUENCY METER

The FREQUENCY METER indicates the frequency of the vibration in cycles per minute (CPM). The meter indicates frequencies of vibration from 120 to 600,000 CPM in four ranges as selected by the FREQUENCY RANGE SELECTOR. The frequency meter reading indicates the synchronous filter frequency, except in the FILTER OUT/FREQ mode. In this case, it is an indicator of a dominant vibration frequency.

The green "TEST" area of the FREQUENCY METER is used in conjunction with the "TEST" position of the FUNCTION SELECTOR to check the instrument for proper operation. See "Circuit Operation Check" in the section PREPARATION PROCEDURE.

FUNCTION SELECTOR

The FUNCTION SELECTOR position determines the mode of operation:

1. TEST. Checks the instrument for proper operation. See "Circuit Operation Checks" in the PREPARATION PROCEDURE.

2. BALANCE. In the balance mode measurements of the vibration amplitude and phase at rotating speed are made with an extremely narrow filter (10 CPM or 0.16 Hz). The frequency tuning of the synchronous filter is automatic by use of a reference pickup (electromagnetic or photocell) or tachometer output, which also serves as the phase reference.

3. TRACK. For this mode of operation the external reference signal is used as in balancing, but the synchronous filter bandwidth is larger (see descriptive specifications). By using a larger filter bandwidth the vibration amplitude and phase can be "tracked" rapidly and recorded simultaneously. Balancing may be done in TRACK mode if speed variations are too rapid to obtain stable readings in BALANCE mode; however, the filtering capability is reduced.

4. FILTER-OUT/SPEED. This mode of operation allows overall (broadband) vibration amplitude to be measured and recorded as a function of rotating speed.

5. FILTER-OUT/FREQUENCY. Overall vibration amplitude and dominant frequency is measured in this mode.

6. SPECTRUM ANALYSIS. In this mode of operation an integral reference signal is swept from the low to the high frequency of the selected FREQUENCY RANGE. An amplitude versus frequency analysis can be recorded using either the LINEAR or LOG OUTPUT for amplitude and the FREQUENCY OUTPUT for frequency. Phase is not measurable in this mode.

POWER SELECTOR

The POWER SELECTOR disconnects all power from the analyzer circuits on the "OFF" position. In the ON position, the instrument receives power which is obtained by connecting the power cable to an external 117 volt, 50, 60, or 400 Hz power source. (Internal wiring changes permit 234 volt operation.)

When the POWER SELECTOR is illuminated, power is being applied to the instrument.

PHASE METER

The PHASE METER indicates the relative phase between the reference pickup or tachometer signal and the synchronously filtered vibration. The phase meter is used in the BALANCE and TRACK modes of operation. The advantages of remote phase indication are safety (both operator and intrinsic), convenience, accuracy and the ability to record phase versus frequency. The entire phase range of 0° to 360° is divided into two ranges of 0° to 180° (blue) and 360° to 180° (red). A patented method is employed to automatically switch phase

meter scales and to indicate which scale to read. The usual discontinuity at 0° and 360° (the meter jumping back and forth between zero and full-scale) is eliminated.

PHASE SCALE INDICATORS

The PHASE SCALE INDICATORS show the proper PHASE METER scale to read. When the red indicator is illuminated the top phase meter scale (red, 360° to 180°) is read. When the blue indicator is illuminated the bottom phase meter scale (blue, 0° to 180°) is read. Neither indicator is illuminated when the instrument is being operated in modes having no phase meaning (Filter Out and Spectrum Analysis).

PHASE ADJUST CONTROL

The PHASE ADJUST CONTROL can be used to set the relative PHASE METER reading to any convenient starting point. This feature is useful in balancing and tracking because it is convenient to start at a major phase (0°, 90°, 180° or 270°) in drawing the balancing vector diagram.

RECORDER SELECTOR

The RECORDER SELECTOR allows calibration of an XY or XY_1Y_2 recorder by providing a zero and full-scale signal to the recorder for amplitude and frequency scale calibration. The recorder's ZERO CAL and F.S. CAL are adjusted in conjunction with MIN/MAX FREQ selectors respectively. When recording phase, PHASE ADJUST in conjunction with PHASE METER reading sets the calibration points.

MIN/FREQ and MAX/FREQ CONTROLS

These controls set the minimum and maximum frequency limits of the sweep circuit in approximately 10% steps when only a portion of the frequency range is to be swept. This reduces the time for recording the data. (See page 31 for the procedure in setting these controls.

RESET/START SELECTOR

Spectrum Analysis:

The RESET/START SELECTOR serves two related functions: (1) starts the sweep and lowers the recorder pen. (There is a short delay before sweep starts.) (2) returns the sweep with the recorder pen in the raised position to the beginning of the sweep. Note that the pen is automatically raised at the

end of the sweep. A push-push switch is used. When the light is illuminated, the switch is in the start mode.

Other Recording Modes:

The RESET/START SELECTOR serves as the pen up or down control. With no light the pen is up. Depress the pushbutton, the light comes on and pen goes down. Depress the pushbutton again, the light goes off and the pen lifts.

MANUAL TUNE CONTROL

This control permits the analyzer to be manually tuned to any frequency for detailed investigation when in the SPECTRUM ANALYSIS mode. The AUTO/MANUAL SELECTOR is set to the MANUAL position for manual tuning.

AUTO/MANUAL SELECTOR

When in the SPECTRUM ANALYSIS mode this switch selects automatic frequency sweep in the AUTO position, or manual tuning by means of the MANUAL TUNE CONTROL when in the MANUAL position.

All input and output connections to the analyzer are made at the side panels.

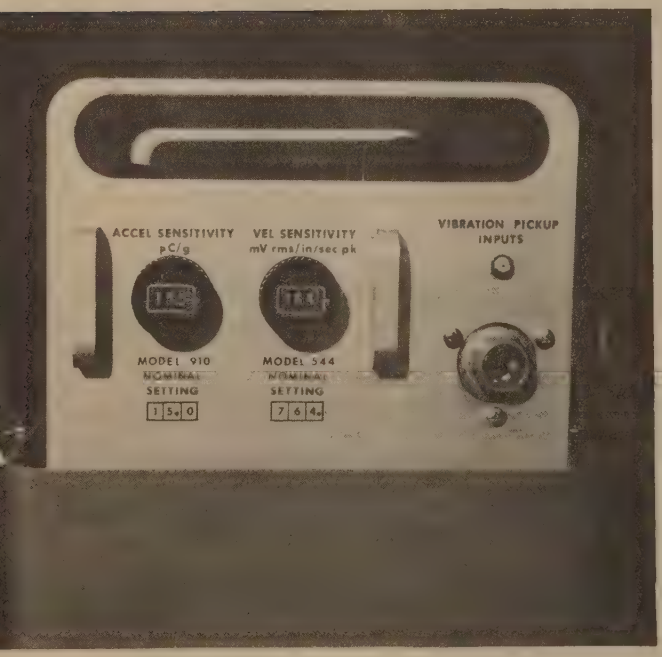


Figure 2. Left Side Panel

Figure 3. Right Side Panel

LEFT SIDE PANEL

VIBRATION PICKUP INPUTS

The larger three-pin receptacle is for a velocity pickup, Model 544 or other type, with sensitivity up to 1000 mV rms/in/sec pk, or accelerometer with sensitivity up to 100 pC/g.

The smaller single-pin receptacle is for an accelerometer using a Microdot cable connector. NOTE: Cables should not be connected to both connectors at the same time.

VEL CAL CONTROL

When using the Model 544 Vibration Pickup set the VEL CAL CONTROL nominally to 764 (764 mV rms per in/sec pk is the nominal sensitivity of the Model 544 Pickup).

When using a velocity pickup with sensitivity up to 1000 mV rms/in/sec pk set the VEL CAL CONTROL to that sensitivity in mV rms/in/sec pk.

NOTE: The 544 sensitivity is 764 mV rms/in/sec pk ±10%. The exact sensitivity in mV rms for one mil displacement at 100 Hz is the last three numbers of the serial number. Multiply this figure by 3.18 to convert to mV rms/in/sec/pk (240 x 3.18 = 764, for example).

ACCEL CAL CONTROL

When using an accelerometer transducer, set its sensitivity in picocoulombs per peak g by means of the ACCEL CAL CONTROL. For example, when using IRD Model 910 Vibration Pickup having a sensitivity of 15 pC/g, set the ACCEL CAL CONTROL to 15.0. (For accelerometer having a sensitivity of 100 pC/g, set 99.9 on the control.)

RIGHT SIDE PANEL

REFERENCE PICKUP RECEPTACLE

The REFERENCE PICKUP receptacle receives the connector on the reference pickup cable from the electromagnetic or photoelectric reference pickup.

POWER CABLE RECEPTACLE

The Power Cable receptacle receives the twist-lock connector on the power cable used in connecting the 360 instrument to the 117-volt, 50/60/400 Hz power line (234 volts usage is optional, on request).

PEN LIFT RECEPTACLE

The Pen Lift receptacle receives the BNC connector of the Pen-Lift cable to connect the analyzer to the X-Y or X-Y_1Y_2 recorder. The Pen Lift provides a pen-down action when the Sweep Reset-Start control is depressed to start the sweep. Immediately after the sweep is completed, the pen is raised automatically. A second depression of the Sweep Reset control returns the pen to the origional position. With recorder Part No. 12052, use the Pen Lift cable supplied with the recorder. With the X-Y_1Y_2 recorder,Part No. 9787, use Pen Lift cable Part No. 9383.

PURGE CONNECTION

The Purge Connection is a 1/8 -27 NPT threaded hole provided for air purging the analyzer. A plug seals the hole when it is not used. The plug can be removed using a 3/16-inch Allen type wrench.

POWER LINE FUSE

The Power Line fuse protects the analyzer AC power supply. This fuse is rated at 1/2 ampere. It is type 3AG,Slo-Blo,Part No. 5276,for 234 volt operation.

SCOPE RECEPTACLE

The unfiltered vibration signal is available at the Scope receptacle for observing the input signal on an oscilliscope. For a full-scale Amplitude meter deflection, the signal voltage is approximately 0.7 volt RMS. The signal is proportional to Displacement, Velocity, or Acceleration depending upon the position of the Pickup Selector control.

REFERENCE OUTPUT RECEPTACLE

The REFerence OUTput receptacle provides a 7-volt RMS sinusodial signal at the reference signal frequency in the Balance and Track operational modes. The purpose of this output is to provide a signal to a vibration exciter (not supplied) for performing modial studies. The modial characteristics of a mechanical system consist of the amplitude and phase of vibration at various points in the system due to excitation at a specific frequency.

FREQUENCY OUTPUT RECEPTACLE

The FREquency OUTput RECEPTACLE furnishes a 7.5-volt peak square wave for driving an externally located digital frequency meter. This meter is used when the frequency measurement accuracy requirements exceed those provided by the 360 instrument meter.

AMPLITUDE LOG RECEPTACLE

The AMPlitude LOG RECEPTACLE outputs a DC voltage proportional to the log of the input signal amplitude. This output voltage is 10 dB per volt with 5 volts DC resulting from a full-scale Amplitude meter reading.

AMPLITUDE LINEAR RECEPTACLE

The AMPlitude LINear RECEPTACLE outputs a DC voltage which is a linear function of the signal amplitude. A full-scale signal results when the output at this receptacle is +5.0 volts.

FREQUENCY RECEPTACLE

The FREQuency RECEPTACLE outputs a DC voltage consisting of a linear function of frequency. A full-scale reading on the instrument Frequency meter results from a +6.0-volt output at this receptacle.

PHASE RECEPTACLE

The Phase Receptacle outputs a DC voltage which is linear with Phase. A 0° phase reading on the instrument Phase meter results in a zero output.However, a 360° phase reading on this meter provides a +3.6-volt output at this receptacle.

NOTE: The IRD Mechanalysis XY_1Y_2 recorder, Part No. 9787, records both Amplitude and Phase from the AMP LOG, AMP LIN, FREQ, and PHASE receptacles. The XY Recorder, Part No. 12052 records Amplitude or Phase vs. Frequency.

INSTRUMENT CASE, ACCESSORY CARRYING CASE and STANDARD ACCESSORIES

The Model 360 instrument is housed in a carrying case of lightweight aluminum with an attractive, tough vinyl coating. Heavy protective bumpers encircle the case to help prevent damage to the instrument and accessories from shock.

The top section of the case provides protection for the front and side panels of the instrument. The analyzer section and top section are gasketed for a tight seal when storing the unit.

The ACCESSORY CARRYING CASE has storage provisions for all standard accessories and space available for optional accessories. (Figure 4.)

ELECTROMAGNETIC REFERENCE PICKUP

The ELECTROMAGNETIC REFERENCE PICKUP, Part No. 5106, provides a once per revolution reference pulse to the Model 360. A reference signal is required in the balancing, tracking or filter out/speed modes.

25' REFERENCE PICKUP CABLE

The 25' REFERENCE PICKUP CABLE, Part No. 9557, with Adapter Cable, Part No. 9556, connects the Electromagnetic Reference Pickup, Part No. 5106, to the Model 360. Photoelectric Reference Pickup, Part No. 5262, (available as an optional accessory) plugs directly into the reference pickup cable (adapter cable not used).

MODEL 544 VIBRATION PICKUP

The Model 544 VIBRATION PICKUP, Part No. 4526, senses mechanical vibration and transduces it into an electrical signal proportional to the velocity of the vibration. It may be used in any position without affecting sensitivity or accuracy. It is sensitive to vibration only along its long axis. See specifications for performance data.

25' PICKUP CABLE

The 25' PICKUP CABLE, Part No. 10393, connects the Model 544 Vibration Pickup to the VIBRATION PICKUP receptacle located on the left side panel of the instrument.

POWER CABLE WITH ADAPTER

The 8-feet,3-wire power cable (Part No.2914) is provided for connecting the 360 instrument to 117-volt,50/60 Hz supply voltage (or 234-volts with internal changes). The cable is supplied with a 2-prong adapter.

CAUTION For safe operation,the green wire on the adapter must be connected to a proper electrical ground.

Standard Accessories:

A. Carrying Case

B. 25-Ft.Cable for the 544 or 544M Vibration Pickup

C. 8-Ft.Power Cable with Adapter

D. 25-Ft.Reference Pickup Cable

E. Model 544 Vibration Pickup

F. Straight Probe

G. Electro-magnetic Reference Pickup

H. Reference Pickup Cable Adapter

Figure 4 Standard Accessories for the 360 Instrument

PREPARATION PROCEDURE

To prepare the Model 360 Vibration Spectrum Analyzer/Balancer for operation with the 544 Pickup, proceed as follows:

1. Connect one end of the velocity pickup cable to the Model 544 Pickup and the other end to the VIBRATION PICKUP INPUT RECEPTACLE at the left side of the analyzer.

   NOTE: Step 2 may be omitted if only spectrum analysis is desired.

2. Connect one end of the ADAPTER CABLE to the Electromagnetic Pickup and the other end to the REFERENCE PICKUP CABLE. The other connector of the cable connects to the REFERENCE PICKUP RECEPTACLE at the right side of the analyzer.

   A Photoelectric Pickup (optional accessory, Part No. 5262) can be attached to the REFERENCE PICKUP CABLE in place of the Electromagnetic Pickup (the ADAPTER CABLE is not used).

   Also, if an A.C. tachometer output is available it can be used as a reference signal with proper cable adapter (not furnished).

   Mounting instruction for the reference pickups can be found on pages 60 through 67.

3. Connect the power cable to the power cable receptacle and to a 117 volt 50/60 Hz outlet (or 234 volt for instruments so wired). If the power outlet is for a two-prong receptacle, use the power cable adapter provided and connect the green adapter wire to a good electrical ground. Set the POWER selector to ON. The power lamp should light, indicating power is being applied to the instrument.

4. Circuit Operation Checks:

   a. Set the FUNCTION SELECTOR to TEST

   b. Set the FREQUENCY RANGE SELECTOR to 600-6K CPM

   c. Set the POWER SELECTOR to ON. Observe that the green light is illuminated.

NOTE: The Circuit Operation Check is independent of the ACCELeration and VELocity CALibration CONTROLS.

A meter reading within the green test area on both the AMPLITUDE and FREQUENCY METERS* indicates normal operation. Also the indication on the PHASE METER is a function of the PHASE ADJUST CONTROL and should be adjustable over the entire 360° range, noting switching operation of the scale indicator lamps.

Analyzer Case Purging

The PURGING connection is provided for flushing and pressurizing the instrument case with clean air or a dry, inert gas to exclude harmful gases, dusts, and vapors which may be present in some environments. Purging air may be obtained from an instrument air supply. Shop air must be thoroughly filtered to remove water, oil and dirt particles.

To use the purging connection, remove the plug and install a 1/8" NPT fitting to a 0-50 psi regulator connected to the air supply. A pressure of 10-30 psi into the instrument case is sufficient to flush the case and maintain a slight positive pressure inside the case. (Air will flow out through various openings in the front panel and end panels.)

CAUTION: Do not exceed 50 psi. Purge the case for 15 minutes before turning the instrument on.

*On some units the green test area of the frequency meter spans from 320 CPM to 400 CPM. When operated on 50 Hz in the TEST mode the frequency meter will read 300 CPM, which is below the green test area. A reading between 285 and 315 CPM indicates normal operation.

BALANCE MODE

Unbalance is probably the most common cause of machinery vibration. The Model 360 provides three distinct advantages to the application of in-place balancing of rotating machinery. First, the synchronous filter provides an exceptionally clean vibration signal to permit balancing in the presence of other vibrations. Second, any speed variations in the part being balanced are automatically followed by the synchronous filter. Third, the phase meter not only provides the convenience of phase measurement at a remote location, but also eliminates errors of judgment in making phase measurements with a stroboscopic light. Phase is accurately indicated on the meter, which can be read within ± one degree.

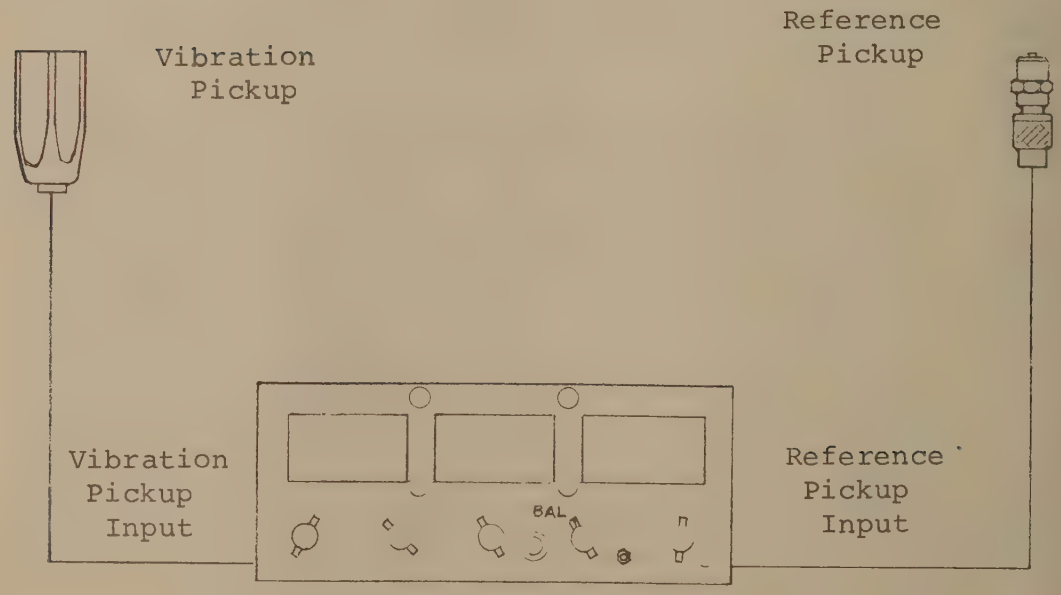


Figure 5. Balance Mode

The Model 360 may be used to balance machines in-place by following the procedure outlined below:

1. Turn the FUNCTION SELECTOR to BALANCE. (To eliminate problems due to sharp and wide fluctuations in a machine's speed, balancing can be done in the TRACK mode which has a wider filter.)

2. Set the RECORDER SELECTOR to OPERATE.

3. Select either displacement by turning to VEL PU (velocity pickup) MILS or velocity by turning to VEL PU IN/SEC with the PICKUP SELECTOR.

   NOTE: Vibration displacement is normally used for frequencies of vibration up to 1200 CPM; above 1200 CPM, vibration velocity is recommended.

4. Set the VEL CAL nominally to 764 when Model 544 Velocity Pickup is used. When using another velocity pickup, set its sensitivity with the VEL CAL CONTROL. (See page 11.)

   NOTE: If it is desired to use an accelerometer (Model 910 Vibration Pickup, optional accessory), connect one end of the accelerometer pickup cable, Part No 10174 *, to the accelerometer and the other end to the VIBRATION PICKUP INPUT RECEPTACLE at the left side of the analyzer. Adjust ACCEL CAL CONTROL to sensitivity of the accelerometer. (1 5 0 nominally for Model 910.) Select either velocity by setting to ACCEL PU (accelerometer pickup) IN/SEC or acceleration measurement by setting to ACCEL PU g's with the PICKUP SELECTOR.

5. Install the reference pickup as described on page 60.

6. Attach the pickup to the point chosen near the vibrating part with the greatest displacement. Use the horizontal or vertical direction, whichever gives the highest reading. Be sure that the location and position of the pickup are the same throughout the balancing procedure. See Model 544 Installation on page 74 or Model 910 Installation on page 78

* Do not use velocity pickup cable, Part No. 10353.

7. Start the machine and allow it to come up to normal operating speed.

8. Select the proper frequency range. The FREQUENCY METER will indicate the reference speed. When the FREQUENCY METER indicates above full-scale or below 1/10 of full-scale the FREQUENCY RANGE SELECTOR must be turned to a higher range (clockwise) or to a lower range (counterclockwise) respectively.

9. Starting with the AMPLITUDE RANGE selection at 1000 (mils, inches/second or g's) turn the selector clockwise until a reading of at least 1/3 full-scale is obtained on the AMPLITUDE METER. This reading is the 1 x RPM at the point where the vibration pickup is applied.

   The AMPLITUDE METER has two sets of linear graduations, above the mirror, 0 to 1; below the mirror, 0 to 3. The setting of the AMPLITUDE RANGE SELECTOR determines which set of graduations apply. If this setting is 1000, 100, 10, 1, .1 or .01 use the top graduations when reading the meter, placing the decimal point as indicated by the AMPLITUDE RANGE SELECTOR. Thus, on the 100 setting, full-scale on the AMPLITUDE METER becomes 100 mils (or in/sec or g's); .6 on the meter becomes 60 mils (or in/sec or g's), etc. If the AMPLITUDE RANGE SELECTOR is set on 300, 30, 3, .3 or .03 use the bottom graduations, placing the decimal point in the same way.

   CAUTION: If the OVERLOAD indicator is continuously illuminated, switch the AMPLITUDE RANGE SELECTOR to a higher range until the indicator is out, or flickers.

10. Adjust the REFERENCE ADJUST CONTROL for steady meter readings. Normally the reading on the REFERENCE ADJUST CONTROL dial is in the range of 4 to 6, but can be out of this range dependent on reference signal waveform.

11. Adjust the PHASE CONTROL to any convenient starting point such as 0°, 90°, 180° or 270°.

12. Since recording is not normally used in balancing, the AUTOMATIC MANUAL and RESET START SELECTORS are not employed.

13. Record the vibration phase as read from the phase meter. Record the vibration amplitude as read from the AMPLITUDE meter. This is the original reading. In the example, Figure 6, the original reading "0" = 6.6 mils @ 150°

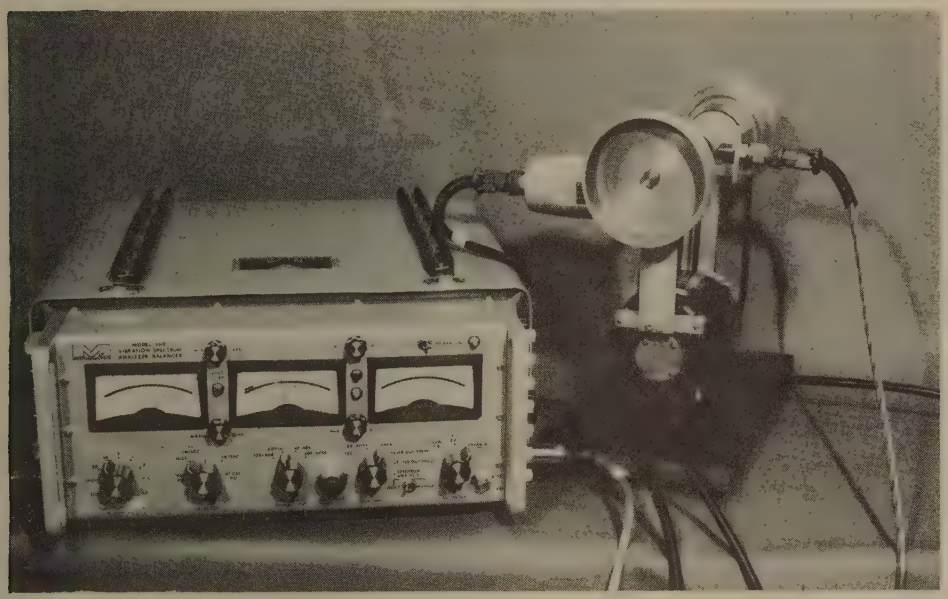


Figure 6. Original Unbalance Readings

14. Stop the machine and add a trial weight at any location on the rotor.

    CAUTION: Attach trial weights securely.

15. Restart the machine and allow it to come up to operating speed. Record the new phase and amplitude reading. This is called the "O + T" (original + trial weight) reading. In Figure 7, O + T = 6.7 mils @ 270° (9:00).

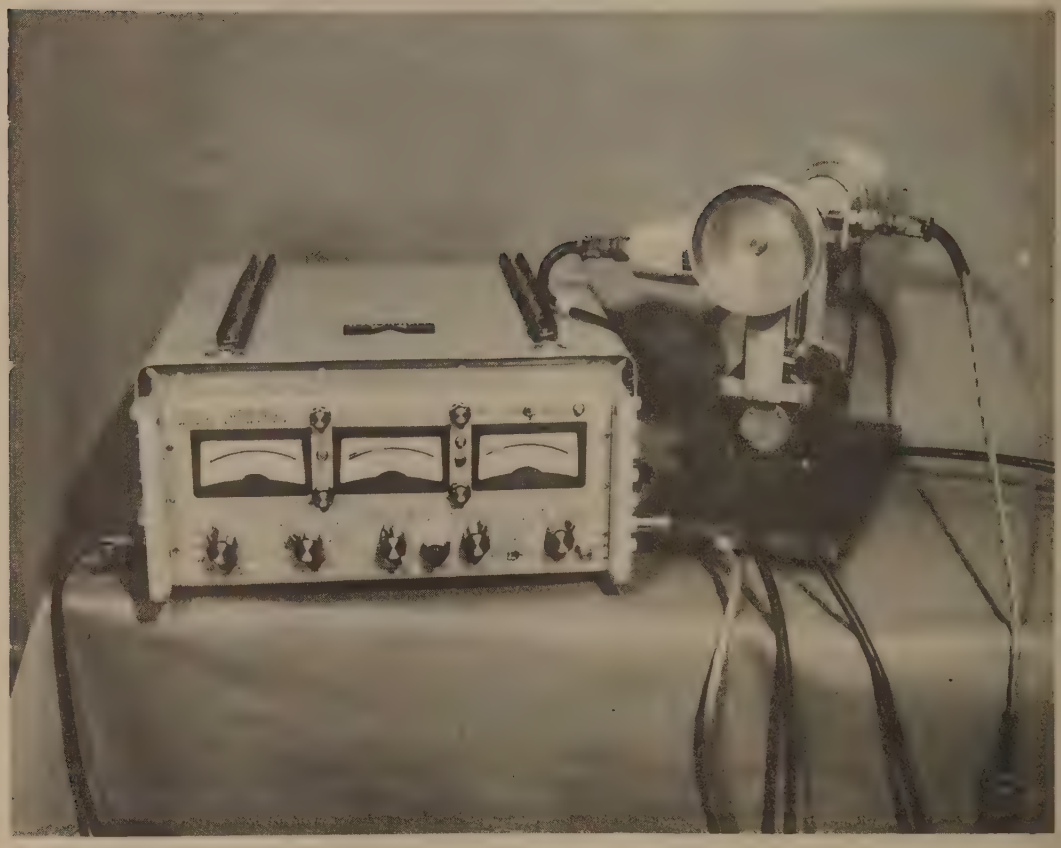


Figure 7, Readings with Trial Weight ("O + T")

The Vibration Severity Chart of Figure 8 applies to most rotating machinery. It can be used as a GUIDE in judging vibration as a warning of impending trouble.

GENERAL MACHINERY
VIBRATION SEVERITY CHART

For use as a GUIDE in judging vibration as a warning of impending trouble.

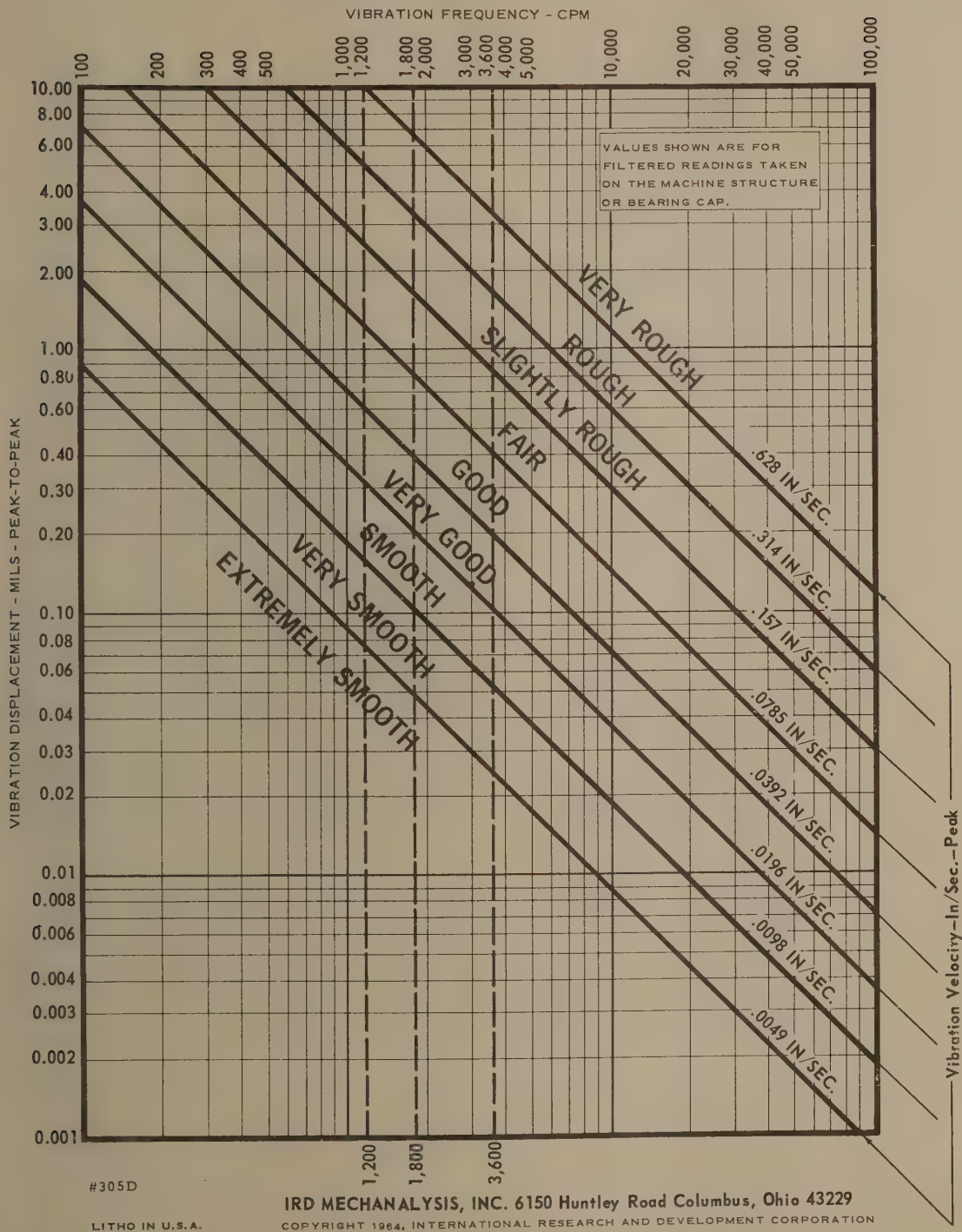


Figure 8 Vibration Severity Chart In Mils, for same chart in Microns, see Figure 33 on page 89

Your judgment must include such factors as safety, economy, the importance of a machine's operation to a plant and its profit, and the degree of risk involved if vibration is ignored. The chart relates vibration displacement and velocity versus frequency or speed (CPM) to severity.

Vector Method:

a. Draw a line on a sheet of polar coordinate graph paper at the same angle as that of the original phase reading, with a length proportional to the original amplitude. Use any convenient scale. Call this line (vector) "O." See Figure 9.

b. In a similar manner, plot the "O + T" reading to the same scale as previously chosen. Label this line "O + T" as shown in Figure 9.

c. Now, draw a line from the end of line "O" to the end of line "O + T" and label this line "T."

d. The angle, measured with a protractor, between line "O" and line "T" is the angle the trial weight should be shifted. The weight should be shifted the opposite direction of the phase reading shift when the rotating shaft is viewed from the end where its rotation is in the clockwise direction. In the example, Figure 9, it is shown that the angle between "O" and "T" is 30°. The phase reading shifted from the original 150° position to the 270° position which represents a clockwise phase shift. Therefore, the trial weight must be moved 30° counterclockwise from the original trial weight position.

   NOTE: If the shaft is viewed from the end where rotation is counterclockwise, the trial weight should be shifted in the same direction as the phase shift.

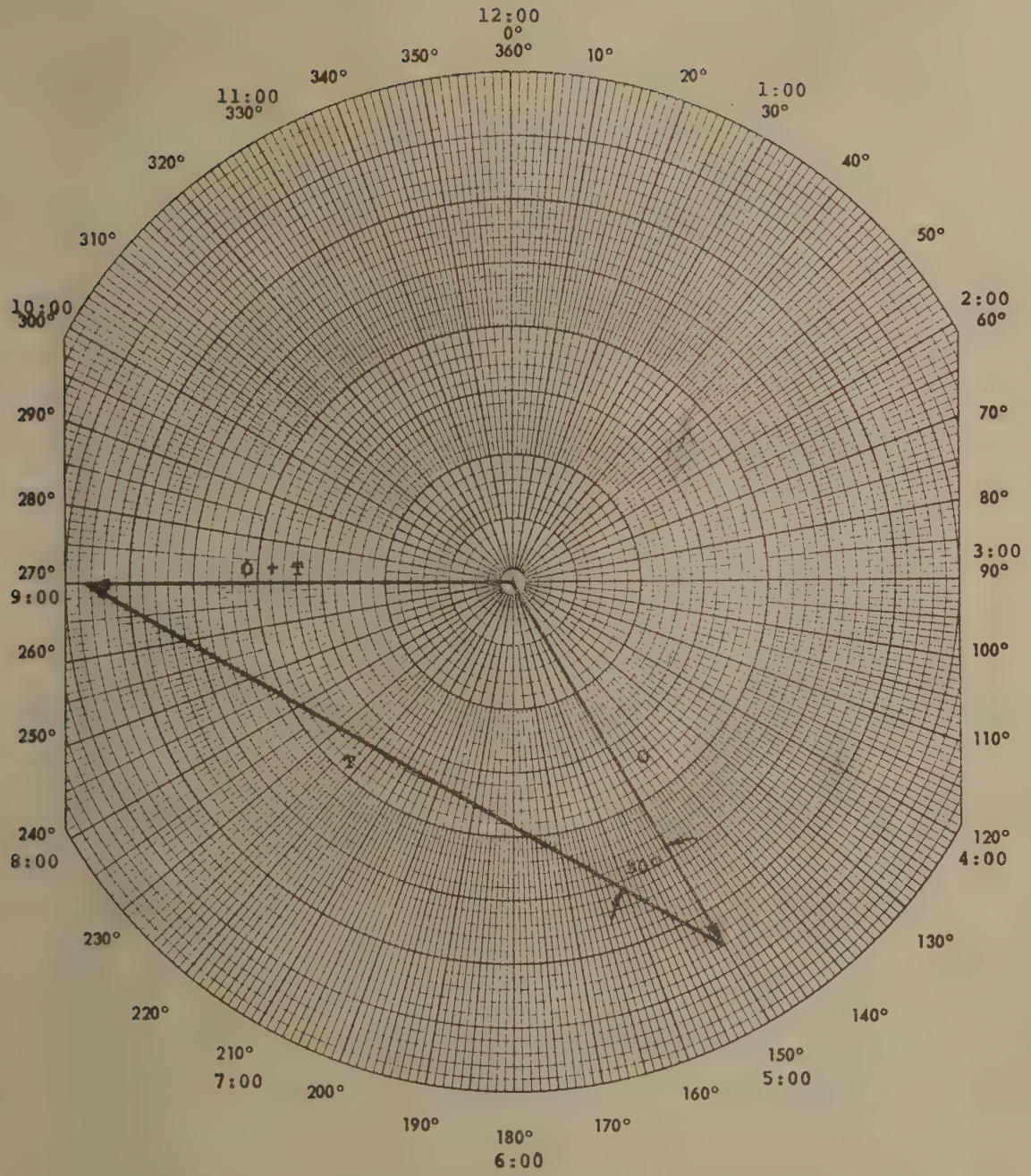


Figure 9. Vector Diagram

e. Determine the correct amount of weight to be applied to the rotating part by multiplying the ratio of the length of line "O" to the length of line "T" by the trial weight:

$$\text{Correct Wt.} = \text{Trial Wt.} \times \frac{O}{T}$$

For the example above, assume the trial weight is 5 ounces. Line "T" measured to the same scale = 11.5. Therefore:

$$\text{Correct Weight} = \text{Trial Weight} \times \frac{O}{T}$$

$$= 5 \text{ ounces} \times \frac{6.6}{11.5}$$

$$= 2.87 \text{ ounces}$$

f. Because the diagram cannot be 100% accurate and the length of the lines cannot correspond perfectly to the amplitude reading, additional runs may be required to meet desired balance tolerances.

There is for each machine a location for the heavy spot (point of unbalance) that is constant. This location is relative to the vibration pickup position and is called the PHASE LAG ANGLE.

Figure 10 shows the method used to determine the PHASE LAG ANGLE. This angle between the vibration pickup position and heavy spot remains constant only when the following conditions are met:

1. Vibration pickup position is fixed.
2. Reference pickup position is fixed.
3. Direction and speed of rotation are fixed.
4. Same instrumentation is used.
5. Machine and installation is unchanged.
6. Phase control is not changed.
7. Reference adjust control is not readjusted.

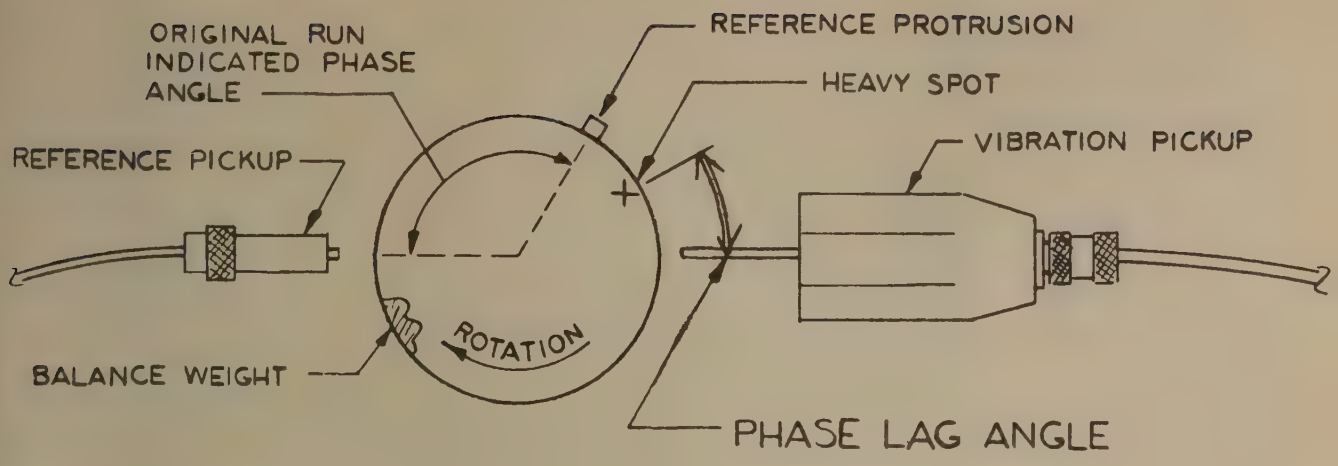


Figure 10. Determining Phase Lag Angle

The PHASE LAG ANGLE is determined as follows:

1. Balance the part.

2. When the machine is at REST, position the reference protrusion at an angle from the reference pickup in the direction of rotation equal to the phase angle indicated on the meter for the ORIGINAL BALANCING RUN (see Figure 10).

3. The heavy spot is located directly opposite the balance weight.

4. The angle between the heavy spot and the vibration pickup is the PHASE LAG ANGLE.

The PHASE LAG ANGLE is useful for: production balancing of similar parts, rebalancing the same machine, and balancing similar machines that meet the conditions outlined previously.

To use the PHASE LAG ANGLE, first attach a protrusion for the reference signal. Assure that the conditions in steps 1 through 4 are met; operate the machine and note the indicated phase angle on the meter. Stop the workpiece and position the reference protrusion at the observed phase angle from the reference pickup. The heavy spot will be located by the PHASE LAG ANGLE from the vibration pickup.

NOTE: The PHASE LAG ANGLE is different for each machine and changes with the operating speed. It cannot be determined until the part is balanced.

For persons familiar with balancing techniques using a strob light and a reference mark on the part, it is helpful to remember that the reference protrusion can be considered as the reference mark and that the phase angle on the meter is the angular position of the protrusion from the reference pickup in the direction of rotation of the shaft. By understanding this similarity, one can apply familiar strob light techniques.

NOTE: For detailed instruction and additional information on balancing, refer to the text "Vibration Analysis and Dynamic Balancing," available to those who have attended IRD MECHANALYSIS, INC. Audio-Visual Training Program. Details on IRD MECHANALYSIS, INC. training programs can be obtained by contacting the nearest representative or writing to IRD MECHANALYSIS, INC., 6150 Huntley Road, Columbus, Ohio 43229.

TRACK MODE

The TRACK and BALANCE operational modes are similar to one another. In both modes, a reference signal is applied, and AMPLITUDE, FREQUENCY, and PHASE METER readings are produced. However, in the TRACK mode, wider bandwidth filters are used so that rapid speed changes do not affect the 360 accuracy. Amplitude and Phase values-versus-frequency values are generally plotted in the TRACK mode. From these plottings, the critical operating speeds (resonances etc.) of the machine can be determined. Frequently, this information is used in establishing the optimum speed range of the machine for both BALANCING and OPERATION.

1. Prepare as in the BALANCE mode of operation, except turn FUNCTION SELECTOR to TRACK.

2. Proceed as with BALANCE, observing AMPLITUDE, FREQUENCY and PHASE METER readings while the machine is accelerating or decelerating in speed within the tracking ability of the synchronous filter (see Specifications).

3. The recorder calibration procedure is the same as in SPECTRUM ANALYSIS except full-scale calibration of phase is setup by adjusting the PHASE CONTROL to 360° on the PHASE METER and zero scale calibration is setup by adjusting the PHASE CONTROL to zero degrees. The recorder zero and full-scale for phase is set as with amplitude.

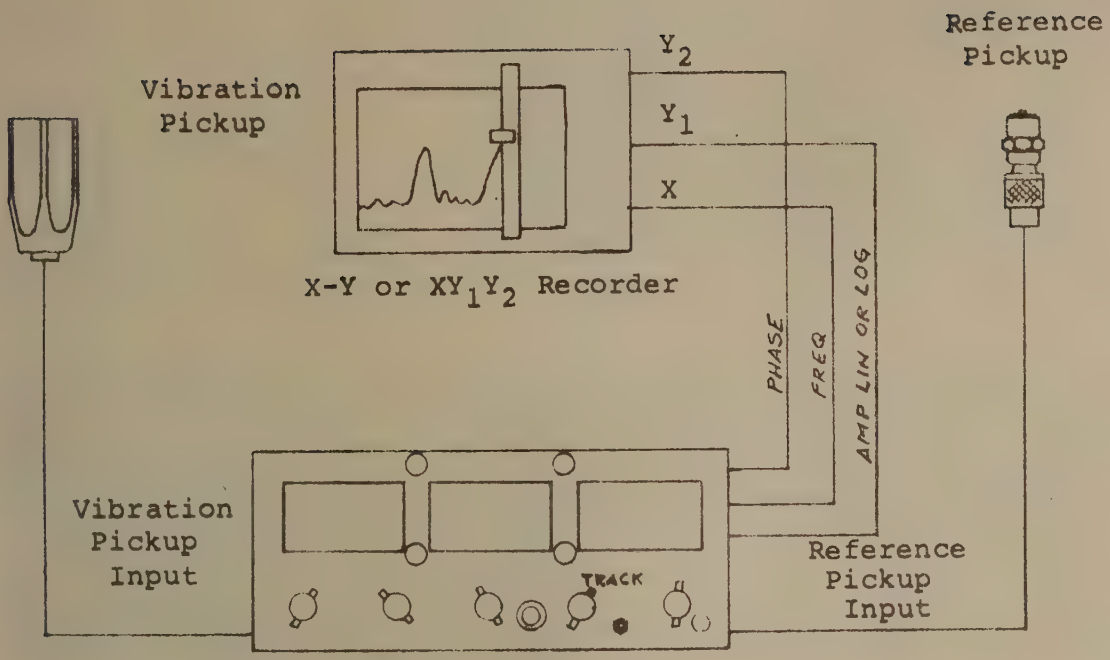


Figure 11. Track Mode

NOTE: TRACK mode may also be used for balancing when faster meter response is desired.

4. The PHASE ADJUST control enables the operator to adjust the phase to any convenient starting point. (Since a phase discontinuity will exist at 360° on the recorder, the control enables the operator to arbitrarily set the starting phase for optimum readout.)

SPECTRUM ANALYSIS MODE

In the Spectrum Analysis mode, the amplitude and frequency of each vibration present is determined. The vibrations can then be related to all known information regarding the machine operation to pinpoint the sources of the vibration. Generally, analyzing machine vibration involves a complex operation. The normal vibration consists of several frequencies of vibration which come from different sources.

Normally, machine vibrations occur at frequencies of 1, 2, 3, 4, and higher multiples and submultiples of the machine rotating speed. A defective component in the machine will increase the level of vibration at one or more of the vibrational frequencies. The rotating speed(s) listed on the machine nameplate are often useful in determining the vibrational frequencies likely to occur in a given machine.

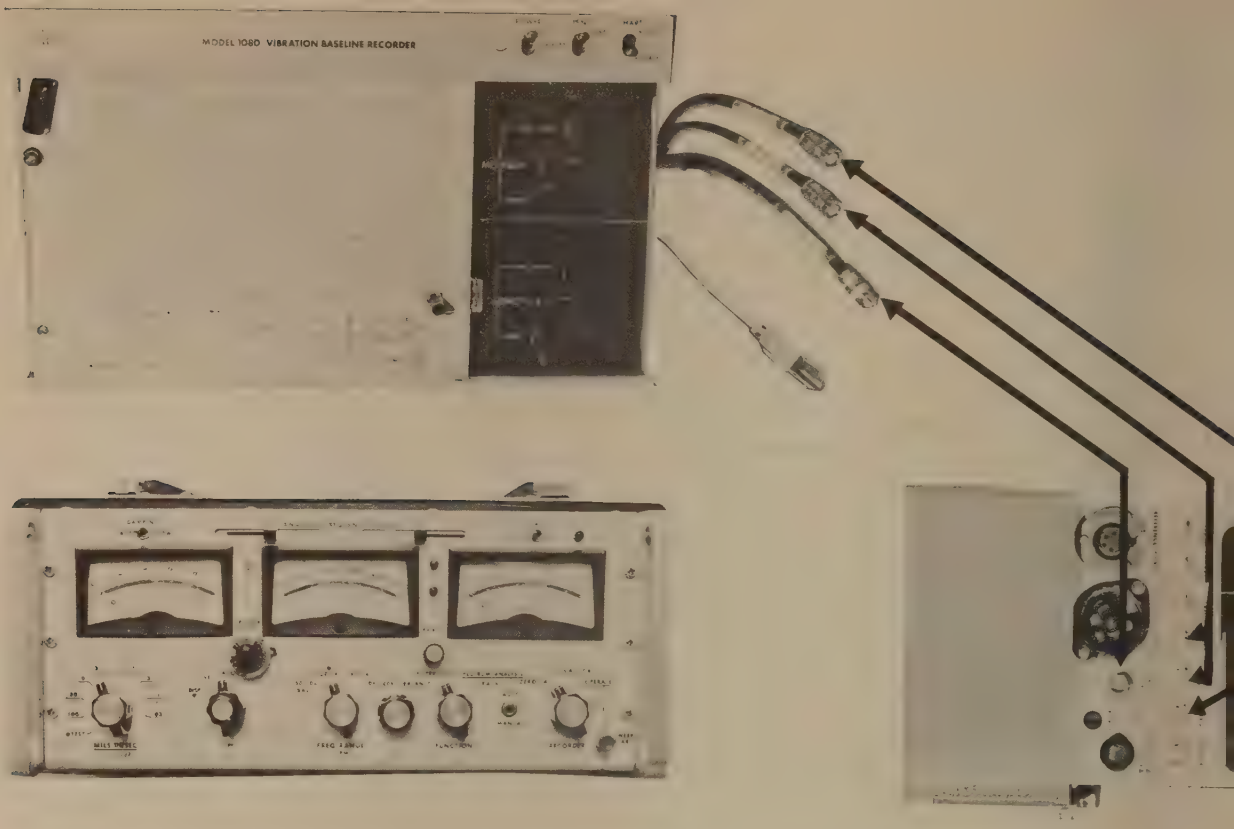


Figure 12 Model 360 Instrument and Model 1080 X-Y Recorder

The Model 360 instrument is used in performing Spectrum Analysis both manually and automatically. In Manual operation,the 360 fil is hand tuned through the desired frequency spectrum. In Automati operation,the filter is electronically swept through the frequenc band. The vibration amplitude at all frequencies can be either o serve on the 360 meters or recorded on an X-Y Recorder data sheet Since phase information is not used in the Spectrum Analysis oper ations,neither a reference pickup nor a tachometer input is neede Setup for operation in the Spectrum Analysis mode is presented in Steps 1 through 21. In conjunction with this setup,see Figure 12

1. Set up the 360 Vibration Analyzer instrument for analysis instructed on pages 16,17,30,31,lnd 32 of this manual.

NOTE: The optional X-Y Recorder,Model 1080, is equipped with interconnecting cables for the power-line voltage,plus the FREQUENCY (X),AMPLITUDE (Y),and PEN LIFT signals fr the 360 instrument. These cables are attached to recept cles at the bottom of the recorder.

2. Turn the X-Y Recorder control switches to POWER-OFF,PEN-UP and CHART-RELEASE.

3. Connect the power-line cable to the supply voltage. See page 3-1 of the recorder manual for details.

4. Connect the FREQUENCY (X),AMPLITUDE (Y),and PEN-LIFT recorder cables to the corresponding receptacles on the 360 instrument (see Figure 12).

5. Insert the recorder pen in the carriage holder after removing the pen cover (see page 3-4 of the recorder manual for details).

6. Set the 360 Analyzer Frequency Range Selector to "600-6K" and the Recorder Selector to "Zero Cal".

7. Place a data sheet on the recorder platen with the lower edge against the bottom of the recorder,and the left-hand edge against the retaining screw.

8. Turn the recorder control switches to POWER-ON,PEN-UP, and CHART-HOLD.

9. Adjust the Recorder ZERO controls for FREQUENCY (X) and AMPLITUDE (Y) until the recorder pen (when in the PEN-DOWN position) marks the data sheet at the 600 CPM and Zero amplitude points.

10. Switch the 360 Analyzer Recorder Selector to "F.S. Cal".

11. Adjust the X-Y Recorder FULL-SCALE control for FREQUENCY (X) and AMPLITUDE (Y) until the recorder pen (in PEN-DOWN position) marks the data sheet at 6000 CPM frequency and full-scale amplitude.

NOTE: The ZERO and FULL-SCALE controls interact with one another. Therefore,Steps 9 through 11 must be repeated until the data sheet readings correspond with the 360 tuning dial readings.

12. Turn the recorder control switches to POWER-STANDBY,PEN-UP, and CHART-HOLD.

13. Switch the Recorder Selector to "Operate",the Function Selector to a position which gives an On-Scale amplitude reading.Also set Pickup Selector to the correct position if not previously done.

NOTE: When frequencies below 600 CPM are to be plotted,the Frequency Range selector is to be placed on "120-600" and the

data sheet frequencies are to be changed from 600 to 600K CPM to read 6K to 60K CPM. (The data from 60 to 120 CPM is below the analyzer cutoff,and is not valid.)

14. Turn the X-Y Recorder control switches to POWER-ON,PEN-UP,and CHART-HOLD.

15. Switch the Function Selector back to "Spectrum Analysis".

16. Push the "Start-Reset" button.After an approximate 10-second delay to allow the electronocs to settle,the pen will commence to plot the vibration spectrum from 600 to 6,000 CPM.

17. When the pen finishes its sweep,push the "reset" button to return the pen to the 600 CPM position on the data sheet.

18 Switch the Frequency Range Selector to "6K-60K" (or "600-6K" if the analysis started at 60-600 CPM),and adjust the X-Y Recorder ZERO control for FREQUENCY (X)until the recorder pen (in PEN-DOWN position) marks the data sheet at 6000 CPM (or to 600 CPM if the analysis started at "60-600").

19. Push the "Start-Reset" button to initiate the pen sweep.

20. Repeat Steps 17 through 19 for the next higher frequency range 60K-600K (or 6K-60K when the analysis started at 60-600 CPM).

21. Switch the X-Y Recorder controls to POWER-ON,PEN-UP,and CHART-RELEASE. Remove the completed data sheet from the recorder platen.

CAUTION

The X-Y Recorder Manual should be reviewed to insure proper operation of the recorder.

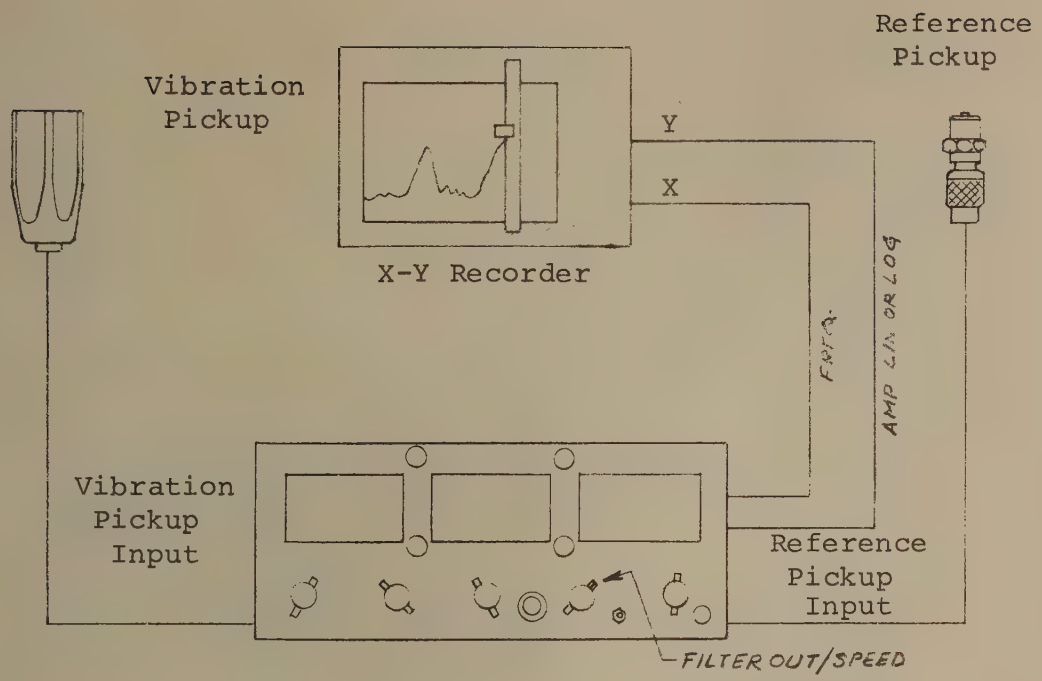


Figure 13. Overall Vibration Mode

OVERALL VIBRATION MODE

1. Select FILTER OUT/SPEED on the FUNCTION control.

2. Proceed as with TRACK mode, except overall (wide band) vibration is plotted rather than filtered vibration. Only amplitude recording is made in this mode.

3. In the FILTER OUT/FREQ position of the function control the dominant frequency of vibration is displayed. No recording is made in this mode.

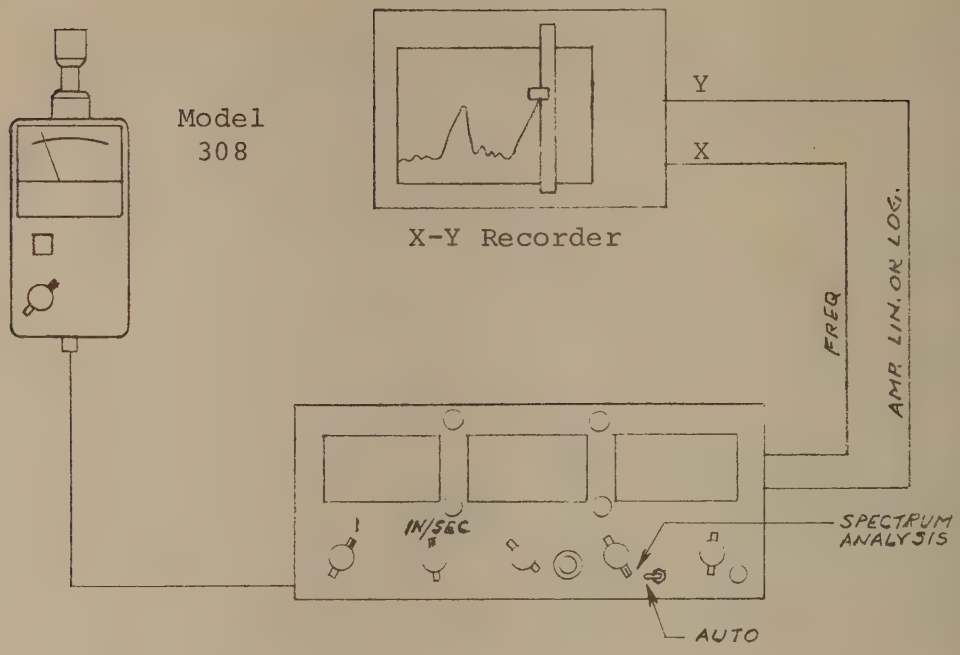


Figure 14. Sound Measurement

SOUND MEASUREMENT

1. Connect the analyzer output of Model 308 Vibration/ Sound Level Meter to the VIBRATION PICKUP INPUT of Model 360 by means of the pickup cable, Part No. 10393.

2. Set sensitivity control to 764.

3. Set AMPLITUDE RANGE SELECTOR to "1" (on metric units set to 10).

4. Set PICKUP SELECTOR to dB.

5. Adjust the Model 308 range selector for a meter reading on the dB scale in "C" weighting.

6. Analyze the sound input signal to Model 360 in the same manner as for vibration frequency analysis.

In FILTER OUT/FREQ the dominant frequency of the sound signal is indicated on the FREQUENCY METER and its amplitude on the AMPLITUDE METER.

In FILTER OUT/SPEED the reference signal frequency is indicated on the FREQUENCY METER.

In SPECTRUM ANALYSIS and AUTO all frequency components and their amplitude are read out and may be recorded on the XY recorder, or in the MANUAL mode a frequency of interest may be tuned in for analysis.

In BALANCE or TRACK mode only those sound signals synchronous with the reference signal would be read on the Model 360 meter.

7. If the amplitude of the frequency components are too small to read on the Model 360 Amplitude Meter, change the Model 360 amplitude range selector as described in Model 308 Manual to ".3" (-10 dB) or to ".1" (-20 dB) and subtract the respective dB from the component amplitude. (On metric units, 0 dB corresponds to 10, -10 dB to 3, and -20 dB to 1.) The dB sound pressure level (SPL) is the sum of the Model 308 range selector setting and Model 360 range selector dB setting and its amplitude meter reading.

8. To set up an XY recorder to plot sound pressure level vs frequency, connect the cable from the AMPLITUDE LOG receptacle to the "Y" terminal of the recorder and the cable from the FREQUENCY receptacle to the "X" terminal of the recorder. Place the RECORDER switch in the F.S. CAL position, and set the upper amplitude and frequency limits on the XY recorder. Mark the upper amplitude limit with the dB level, as set by the Range Selector on the Model 308 and Model 360 plus 10 dB. See also 7. above.

   Set the RECORDER switch to ZERO CAL position and adjust the lower amplitude and frequency limits on the XY recorder. The lower amplitude limit will be 50 dB less than the upper limit. For example, if the upper limit is 90 dB, then the lower limit is 40 dB.

APPLICATION OF MODEL 360 FOR SPECTRUM ANALYSIS

One of the main advantages of the Model 360 is its capability to automatically generate a hard copy, detailed vibration spectrum analysis from 120 to 600,000 CPM. The key to diagnosis of machine mechanical problems often depends on the capability to pinpoint a specific frequency which can be related to a definite component of the machine. For example, a 1200 RPM centrifugal pump with a 5-bladed impeller will produce an "impeller" frequency of 6000 CPM. The same pump may have antifriction bearings with a frequency of 5800 CPM. The Model 360 Analyzer has the resolving power (i.e., narrow bandwidth) to separate these two frequencies into individual vibration peaks for diagnosis of a bad bearing. With less resolution the two peaks would not be separated, and the defective bearing symptom might have been overlooked as merely the characteristic "impeller" frequency of the pump.

In setting up to make a spectrum analysis, the Model 360 Function Selector switch should first be placed in the Filter-Out/Frequency position. The Amplitude Range Selector can then be set so that the entire spectrum will be at, or below, Full Scale when plotted. The Function Selector is switched to the Spectrum Analysis position and the XY recorder calibrated by first setting the Zero Cal and then the F.S. Cal of the Recorder Selector. The Recorder Selector is then placed in the Operate position and the Reset/Start Selector depressed, which initiates the automatic plot of the spectrum.

Figure 15 shows an example of an automatic spectrum analysis of the vibration of the Nodal Bar on a balancing stand. This routine analysis detected and pinpointed the presence of an incipient defect in the drive shaft bearing of the balancing stand. This defect appeared as a frequency cluster centered at about 32,000 CPM. Defective antifriction bearings often show such vibrations in this general frequency range. While not a serious problem, the analysis indicated to the stand operator that a bearing replacement would be needed in the future.

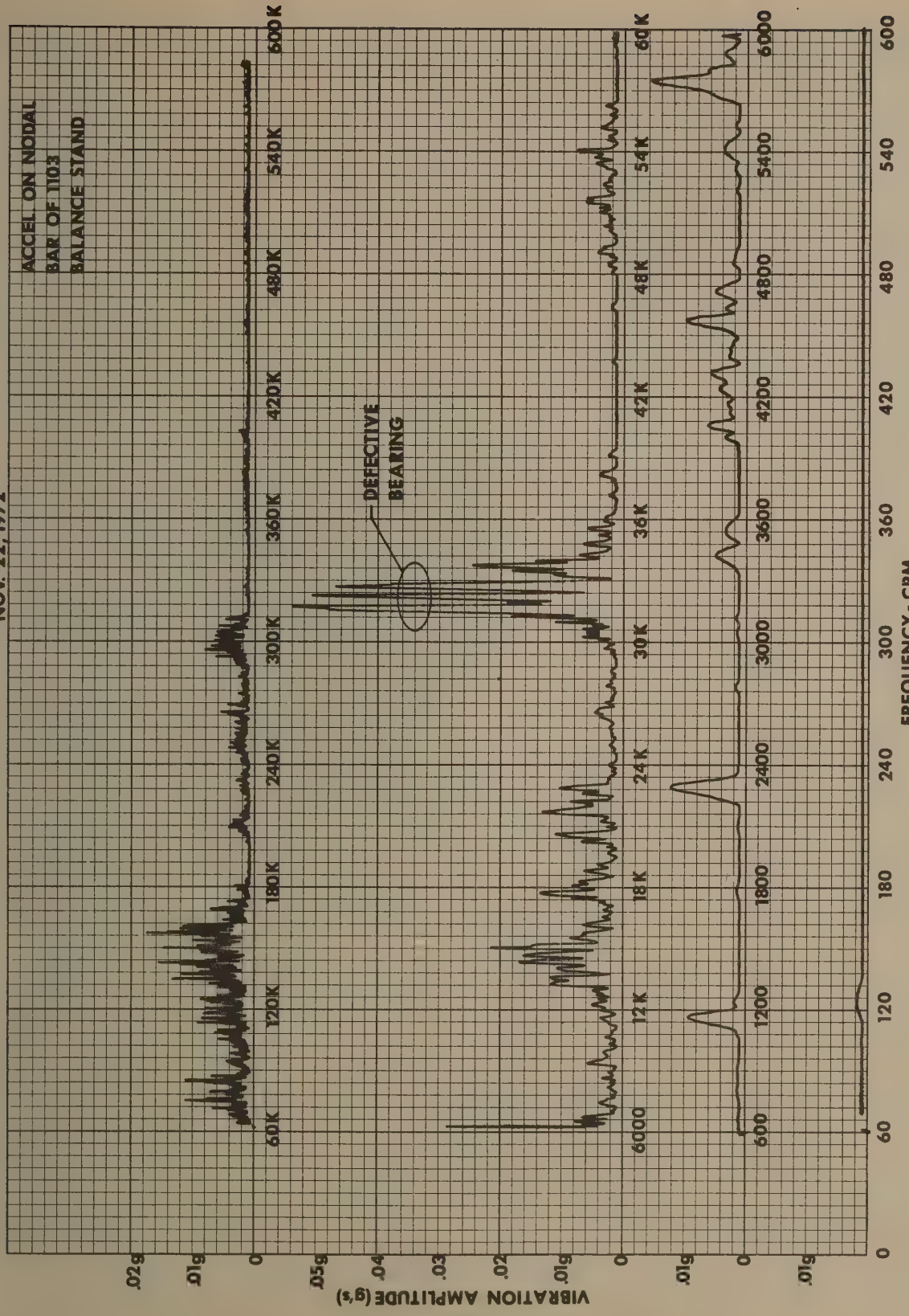


Figure 15. Automatic Spectrum Analysis

Although standard graph paper can be used for plotting spectrum analyses, as is shown in Figure 11, IRD Mechanalysis has available preprinted graphic data sheets made up especially for the Model 360. These preprinted sheets have the significant advantage of reducing the information which the operator must record, and also increase the accuracy of the recorded data.

Three different types of preprinted data sheets are available, each designed to fill a specific need.

Figure 16 (Form 1367) covers the frequency range from 600 to 600,000 CPM, and has an amplitude scale which permits high resolution of the vibration peaks.

Figure 17 (Form 1368) covers the frequency range from 600 to 600,000 CPM, and has provision for recording horizontal, vertical and axial measurements on a single data sheet. This minimizes the number of data sheets, and, most important, provides an easy method of comparing horizontal, vertical and axial spectra which facilitates data analysis.

Figure 18 (Form 1369) covers the frequency range 600 to 6000 CPM, which allows much greater frequency resolution for those analyses requiring precise frequency identification. This frequency scale can be modified for recording higher frequency ranges or be handled in a similar manner to that shown in Figure 11.

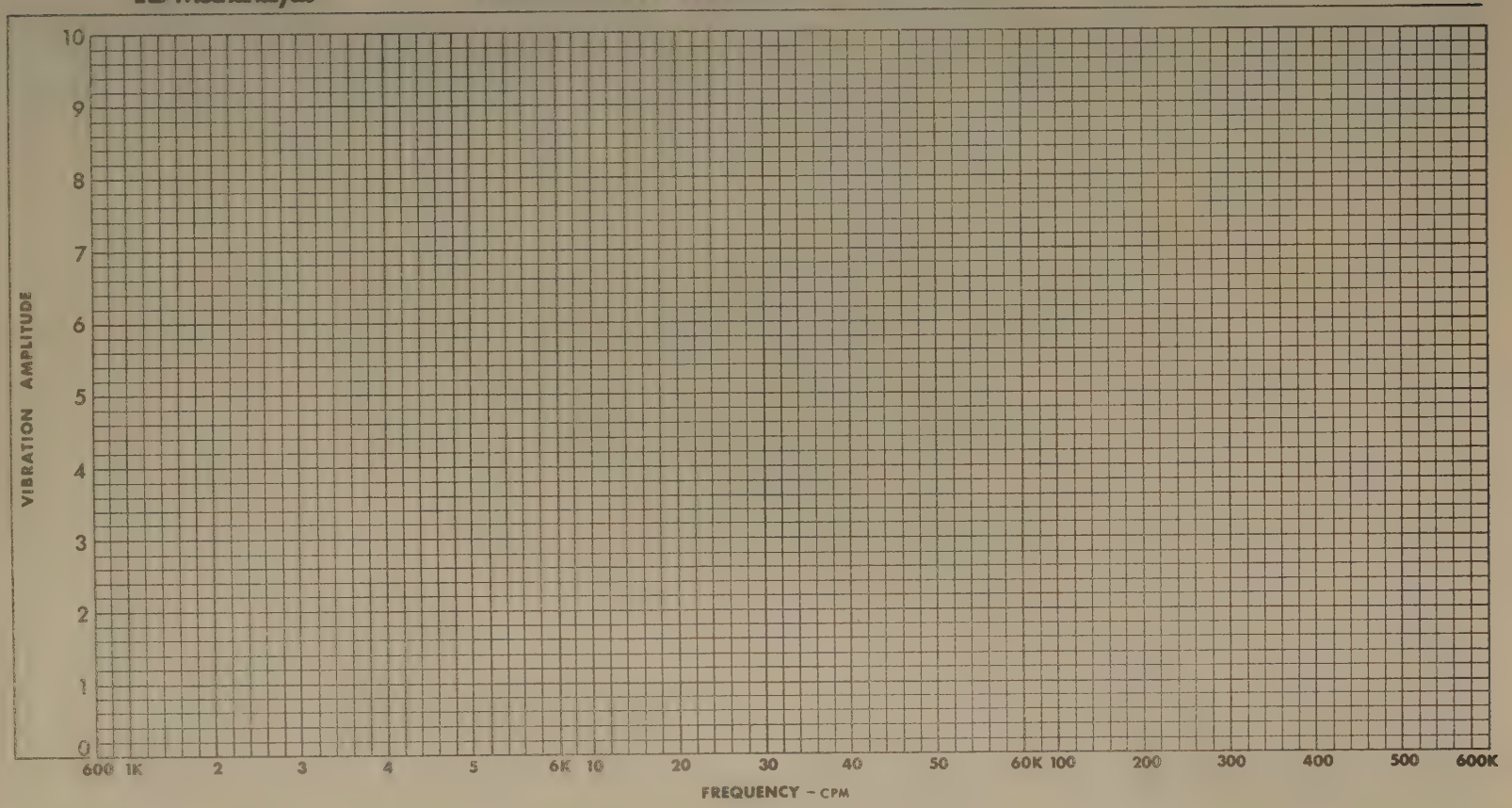
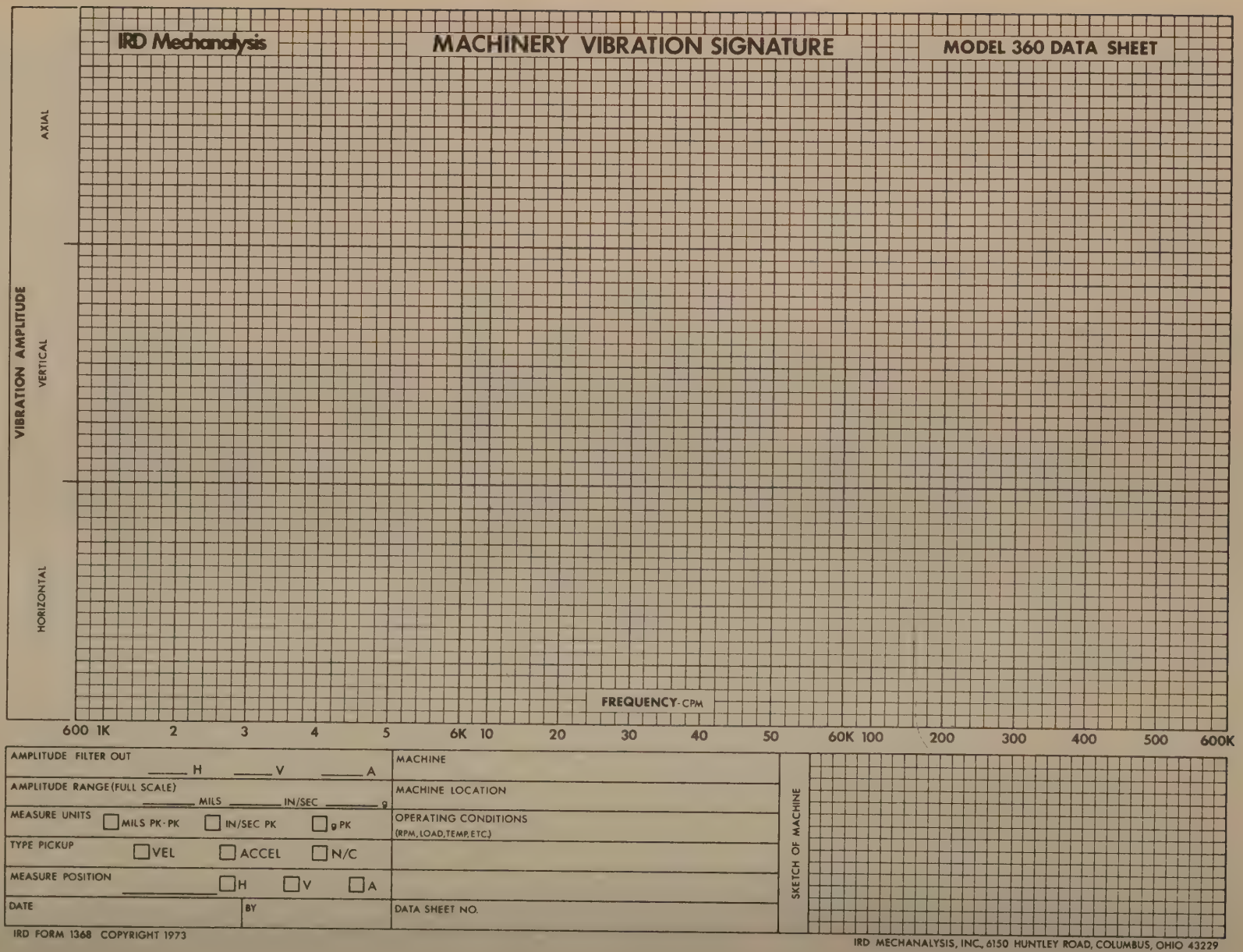

IRD Mechanalysis
MACHINERY VIBRATION SIGNATURE
MODEL 360 DATA SHEET
VIBRATION AMPLITUDE
10
9
8
7
6
5
4
3
2
1
0
600 1K 2 3 4 5 6K 10 20 30 40 50 60K 100 200 300 400 500 600K
FREQUENCY – CPM
AMPLITUDE FILTER OUT
AMPLITUDE RANGE(FULL SCALE)
MILS IN/SEC g
MEASURE UNITS
MILS PK-PK IN/SEC PK gPK
TYPE PICKUP
VEL ACCEL N/C
MEASURE POSITION
H V A
DATA SHEET NO.
DATE
BY
MACHINE
MACHINE LOCATION
OPERATING CONDITIONS
(RPM, LOAD, TEMP, ETC.)
SKETCH OF MACHINE
IRD FORM 1367 COPYRIGHT 1973
IRD MECHANALYSIS INC., 6150 HUNTLEY ROAD, COLUMBUS, OHIO 43229

Figure 16.


IRD Mechanalysis
MACHINERY VIBRATION SIGNATURE
MODEL 360 DATA SHEET
VIBRATION AMPLITUDE
AXIAL
VERTICAL
HORIZONTAL
FREQUENCY-CPM
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AMPLITUDE FILTER OUT
H V A
AMPLITUDE RANGE (FULL SCALE)
MILS IN/SEC g
MEASURE UNITS
MILS PK-PK IN/SEC PK g PK
TYPE PICKUP
VEL ACCEL N/C
MEASURE POSITION
H V A
DATE
BY
MACHINE
MACHINE LOCATION
OPERATING CONDITIONS
(RPM, LOAD, TEMP, ETC.)
DATA SHEET NO.
SKETCH OF MACHINE
IRD FORM 1368 COPYRIGHT 1973
IRD MECHANALYSIS, INC., 6150 HUNTLEY ROAD, COLUMBUS, OHIO 43229

Figure 17.

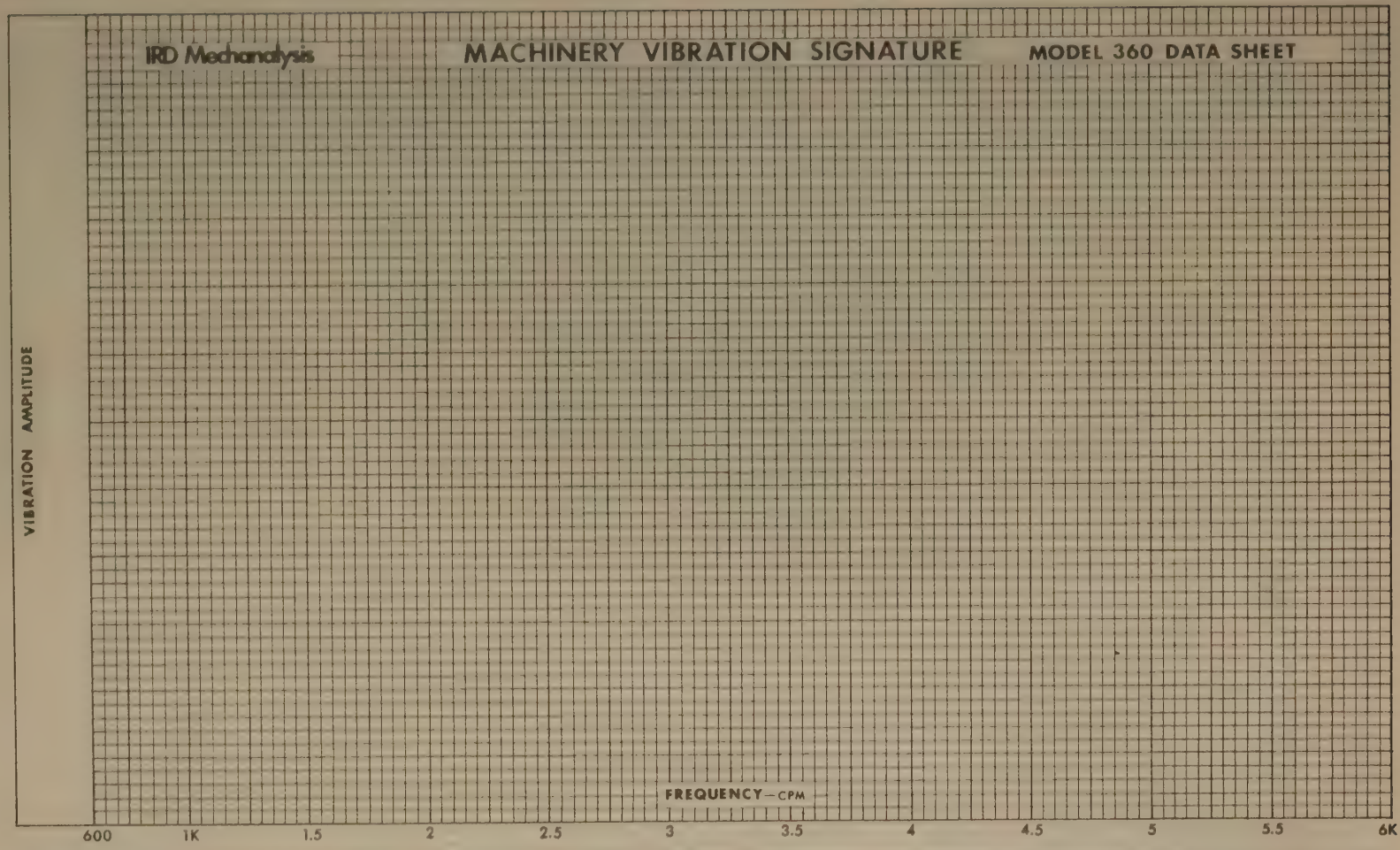

IRD Mechanalysis
MACHINERY VIBRATION SIGNATURE
MODEL 360 DATA SHEET
VIBRATION AMPLITUDE
FREQUENCY—CPM
600
1K
1.5
2
2.5
3
3.5
4
4.5
5
5.5
6K
AMPLITUDE FILTER OUT
AMPLITUDE RANGE(FULL SCALE)
_____ MILS _____ IN/SEC _____ g
MEASURE UNITS
MILS PK-PK
IN/SEC PK
g PK
TYPE PICKUP
VEL
ACCEL
N/C
MEASURE POSITION
H
V
A
DATE
BY
MACHINE
MACHINE LOCATION
OPERATING CONDITIONS
(RPM, LOAD, TEMP, ETC.)
DATA SHEET NO.
SKETCH OF MACHINE
IRD FORM 1369 COPYRIGHT 1973
IRD MECHANALYSIS INC., 6150 HUNTLEY ROAD, COLUMBUS, OHIO 43229

Figure 18.

APPLICATION OF MODEL 360 FOR DETECTING MACHINE CRITICALS & NATURAL FREQUENCIES

For machines which are designed to operate over a wide speed range, and even for those operating at a single speed, it is desirable to determine whether there are any critical speeds of the machine or natural frequencies of associated structures which might cause excessive vibration that can result in early deterioration of machine components.

The Model 360 has been specially designed to obtain this type information.

To make such a check the Model 360 reference pickup (electromagnetic or photocell) is positioned near the machine shaft to provide a reference pulse. As previously mentioned in the Manual, this reference pulse: (1) indicates machine speed, (2) centers the tracking filter exactly at the rotational vibration frequency, and (3) provides the reference for obtaining the phase angle of the vibration signal. The vibration pickup is placed at the point to be checked for critical speed or natural frequency. The bearing housing is generally used as the vibration pickup position for determining machine critical speeds, while the corner of the machine bedplate would be a good starting point for checking for important structural natural frequencies.

The machine is then slowly run up in speed, if possible, from standstill to 10% or 20% above its highest operating speed. Alternatively, for those machines which cannot be brought up to speed slowly, the machine can be allowed to coast down from its highest operating speed.

During this run up, or coast down, the amplitude of the rotational vibration and its phase (relative to the reference position on the shaft) vs. shaft speed, are plotted out automatically by an XY recorder connected to the Model 360. Since the vibration amplitude will vary over a wide range for such a plot, it may be necessary to make more than one run to obtain the proper amplitude range selection setting. If the manufacturer of the machine has specified a vibration tolerance limit, this should be used as the initial amplitude setting.

Figure 19 shows an example of a plot of amplitude and phase vs. speed for the motor bedplate of a balancing stand. Although the amplitudes are insignificant from a vibration standpoint, the readily identifiable vibration peaks can be seen at approximately 1030, 1300 and 1600 CPM. The large phase shift (180°) which coincides with these peaks confirms the fact that these are true resonances caused by coincidence between the motor vibration frequency and the natural frequencies of the motor bedplate.

If it had been found that these resonances were of significant amplitude, it would have provided the designer with the information he needed to correct his design through stiffening, or damping, the bedplate structure.

K•E 10 X 10 TO THE INCH 46 0702
7 X 10 INCHES MADE IN U.S.A.
KEUFFEL & ESSER CO.

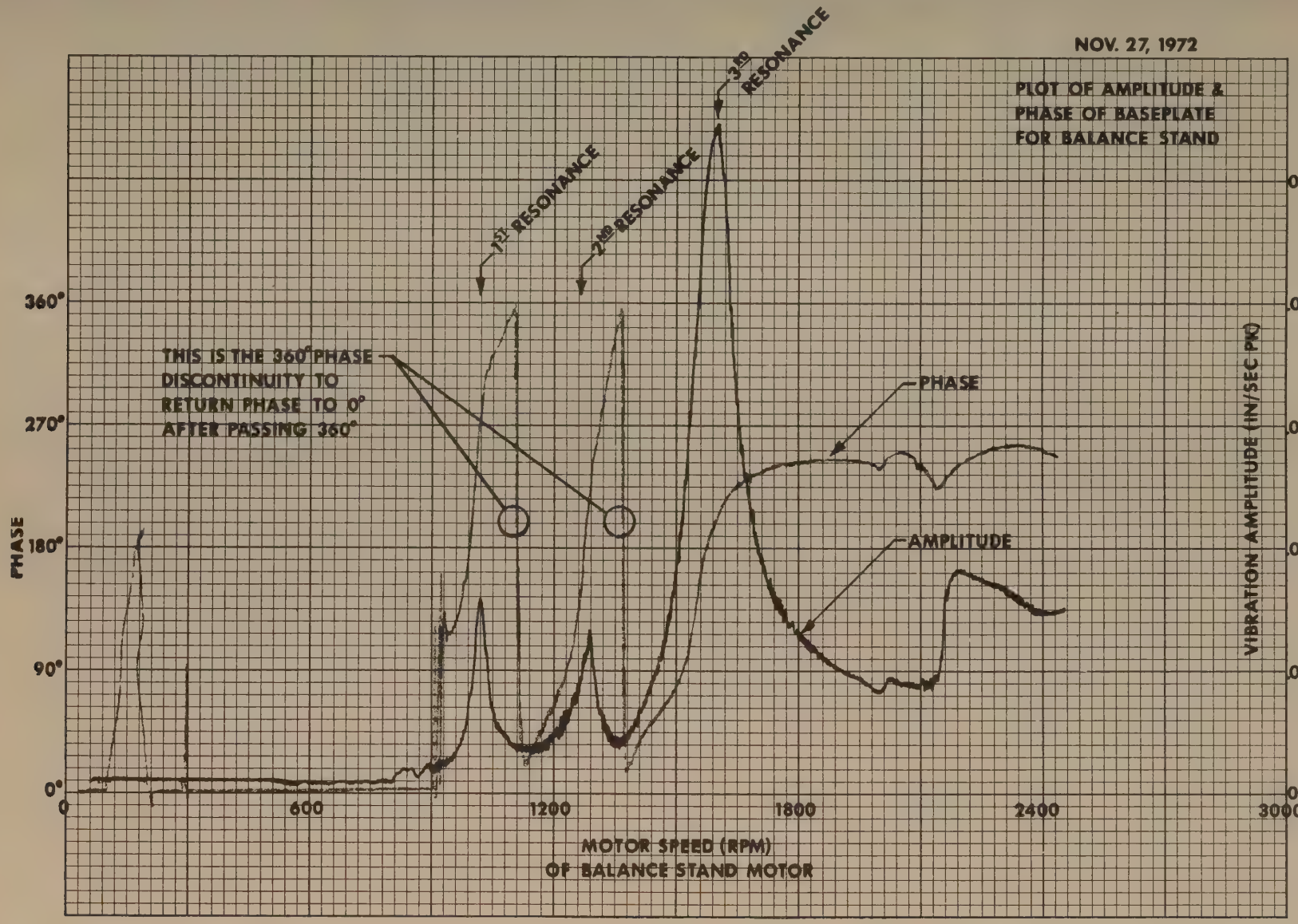


Figure 19

APPLICATION OF MODEL 360 FOR MEASURING DYNAMIC RESPONSE AND MODE SHAPES OF STRUCTURES

The Model 360 has a unique capability for instruments of its type in measuring the dynamic response and mode shapes of all types of structures.

As machine speeds have become higher, as well as power to weight ratios, it has become more important for manufacturers to learn more about the dynamic characteristics of their machines. The dynamic characteristics of the structural environments in which these machines will be operating have also become more important. The best known of these dynamic characteristics are the familiar machine shaft "criticals." But bearing pedestals and stator frames also have dynamic characteristics which can be very important. The machine tool industry is acutely aware of the problems, and solutions, of machine dynamics. In many cases the speed of machining operations is limited by the machine tool's dynamic characteristics. This industry has, therefore, learned to measure a machine's dynamic characteristic, and then modify the design to obtain maximum performance.

In increasing numbers, the foundations where large machines will be located are being checked to determine their dynamic characteristics to anticipate and, if necessary, correct problems before machine installation.

What is meant by "dynamic characteristics" of a structure is its vibration amplitude (i.e., displacement, velocity, or acceleration) in response to a given vibration force. This force is applied to the structure by a pneumatic, hydraulic, mechanical, or electromechanical shaker device. A number of such shakers are available. They range from simple, inexpensive pneumatic vibrators exerting a few pounds of force to custom designed electrohydraulic units capable of producing precise vibration frequencies exerting thousands of pounds.

The force generator selected should be capable of varying the frequency of its vibratory force input over the frequency range of interest. This range will generally approximate the range of rotation speeds of the machine involved. It is also desirable, although not essential in most cases, that the vibratory force input be constant over the complete frequency range.

The force generator should be attached to the structure at the location where it is expected that the input vibration will occur under normal operating conditions. For example, if the structure is a foundation for a rotating machine, the force generator should be attached at the point (or points) which is representative of the position(s) where the machine contacts the foundation. For a machine which has continuous, rather than point, contact with its foundation, attachment of the force generator at one (or perhaps two) corners of the foundation will normally provide adequate information on the foundation's dynamic characteristics.

Bolting, or clamping, of the force generator to the structure is considered the most desirable method of attaching the force generator.

For precision work, where high accuracy is desired, a force gage should be inserted between the force generator and the structure to obtain a precise measure of the actual input force. These specific force values at each frequency of interest can then be divided into the measured amplitude (i.e., displacement, velocity, acceleration) to give the amplitude response per unit force.

In most structures, when a relatively constant vibratory input force is swept over a frequency range, there will be certain frequencies at which the vibration amplitude will become much larger than those adjacent. Such frequencies are the "natural" frequencies of the system, and are of prime interest. Coincidence between these frequencies and the rotational frequencies of a machine create resonances which are generally destructive to the machine and its foundation structure. When this occurs, an effort must be made to eliminate this coincidence. One of two courses of action are usually taken: (1) change the machine's speed so that it does not run at these frequencies, or (2) modify the machine or foundation structure.

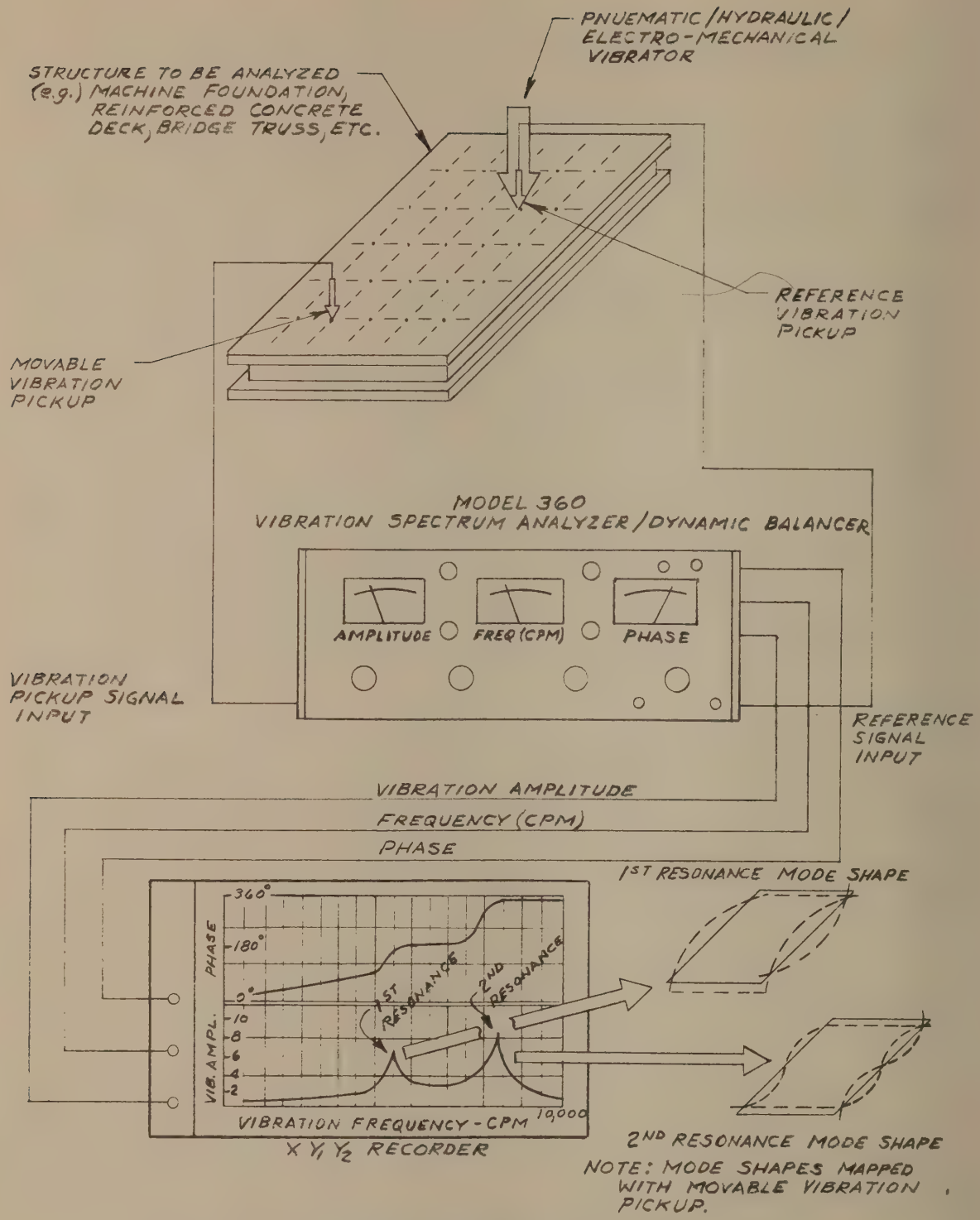
Trial and error modification of the machine or structure can be avoided, if information on the "mode shapes" of its natural frequencies is obtained. The "Mode Shape" of a structure can be defined as the manner in which the structure bends as it vibrates at a natural frequency.

To obtain mode shape data, the structure is driven at its natural frequency. The amplitude and phase (i.e., phase relative to the drive point vibration) is then measured at a number of points over the structure. These measurements may then be used to determine where the structure should be stiffened, or where weight should be added to eliminate the resonance problem.

Figure 20 illustrates how the Model 360 can be used to obtain both the dynamic response and mode shape data. A Model 544 Velocity Pickup is connected to the reference channel cable in place of the electromagnetic pickup, and attached to the structure adjacent to the force generator. A Model 544 Velocity Pickup, or accelerometer, is then connected via cable to the vibration input, and attached to the structure at a bearing housing or foundation attachment point where the dynamic characteristics are of interest.

The force generator is then swept through the frequency range of interest and the Model 360 with XY_1Y_2 plotter used to record the vibration amplitude and phase vs. frequency. Figure 20 illustrates the type of plot generated. The two peaks shown in the Figure are the two natural frequencies of the structure.

To determine the mode shapes associated with these natural frequencies, which are also shown in the Figure, the force generator is tuned to each of these natural frequencies, in turn, and the amplitude and phase recorded over a grid work of points on the structure by moving the vibration input pick-up from point to point. From this amplitude and phase grid, the mode shape can be determined.



SCHEMATIC DIAGRAM SHOWING INSTRUMENTATION FOR AUTOMATIC MEASUREMENT OF BOTH DYNAMIC RESPONSE AND MODE SHAPES OF STRUCTURES.

Figure 20. Mode Shape Data

USE OF MODEL 360 FOR OVERALL VIBRATION VS. SPEED MEASUREMENTS

Final acceptance testing of steam turbines and other machines often includes requirements that the overall (Filter Out) vibration not exceed a certain value over the complete operating speed range of the unit. This may be 0 to 10,000 RPM or higher.

Until the introduction of the Model 360, such tests usually required time consuming manual point-by-point plotting of the amplitude as the machine was slowly brought up or down in speed. To overcome this problem, the Model 360 has been provided with a "Filter Out-Speed" mode of operation which permits a machine's overall vibration vs. speed to be automatically plotted on an XY recorder. Figure 21 shows a typical plot of such a measurement. It enables the test engineer, and the customer, to see at a glance how the machine performs in relation to the vibration specification level.

Further, if such a measurement is compared with a Model 360 measurement in the "Track" mode, which filters out all vibrations except that caused at the rotation frequency, it provides the test engineer with valuable diagnostic information, that tells him whether the vibration levels are primarily caused by shaft rotation, or by some other sources such as an oil whirl. An example of such comparison is shown in Figure 22.

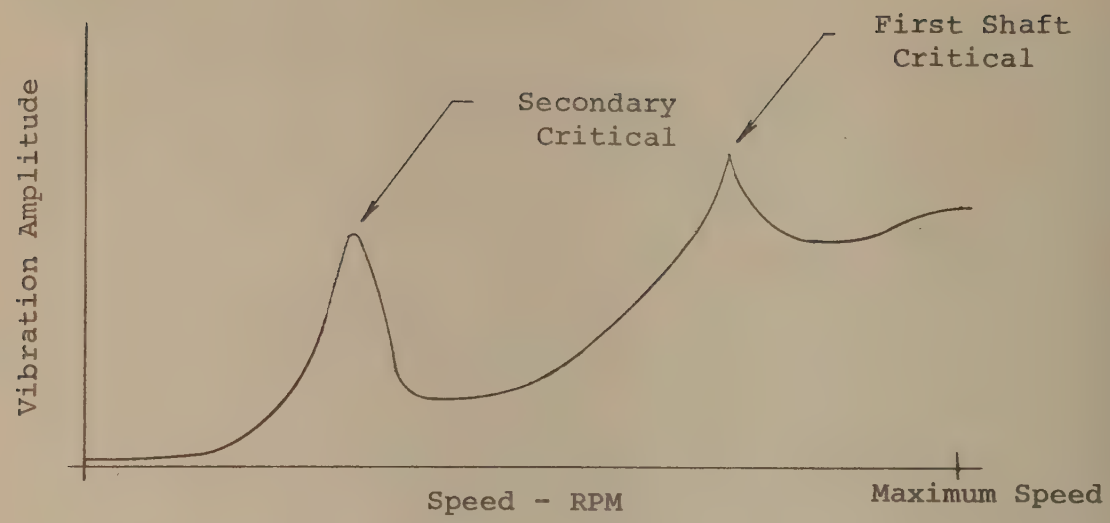


Figure 21. Overall (Filter Out/Speed) Vibration vs Shaft Speed

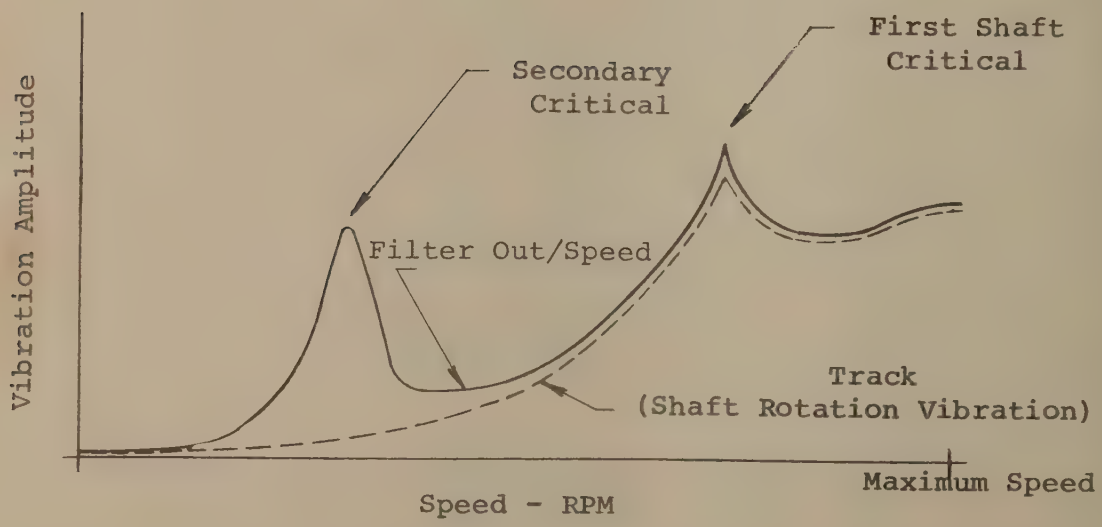


Figure 22. Comparison "Filter Out/Speed" and "Track" (Shaft Rotation Vibration)

MODEL 360 SPECIFICATIONS

FREQUENCY RANGES

120 - 600* CPM (2-10 Hz)
600 - 6,000* CPM (10-100 Hz)
6,000 - 60K* CPM (100-1K Hz)
60,000 - 600K* CPM (1K-10K Hz)

*Each band can be read to 5% above its upper limit to provide an overlap on the frequency range scales.

AMPLITUDE RANGES (Available in English or Metric Units)

(Full Scale Analyzing Ranges)

Displacement (Using Velocity Pickup)	.01-100 mils pk-pk, Full Scale .3-3K microns pk-pk, Full Scale
Velocity (Using Velocity Pickup)	.01-100 in/sec pk, Full Scale .3-3K mm/sec pk, Full Scale
Velocity (Using Accelerometer)	.01-1000 in/sec pk, Full Scale .3-30K mm/sec pk, Full Scale
Acceleration (Using Accelerometer)	.01-1000 g pk, Full Scale
Sound (Using Model 308)	60-140 dB Sound Pressure Level Full Scale

PHASE

Balancing and Tracking	0°-360° continuous (no ambiguity near 0°)

FILTER CHARACTERISTICS

Frequency Range	Balance Mode BW**	Tracking Mode BW**	Track Rate	Spectrum Analysis BW**	Recording Time***
120 to 600 CPM	10 CPM	50 CPM	50 sec.	10 CPM	200 sec.
600 to 6,000 CPM	10 CPM	240 CPM	25 sec.	50 CPM	90 sec.
6,000 to 60,000 CPM	10 CPM	720 CPM	25 sec.	240 CPM	50 sec.
60,000 to 600,000 CPM	10 CPM	720 CPM	250 sec.	720 CPM	130 sec.

**Bandwidth shown for 3 dB attenuation points (70.7% Full Scale)
Bandwidth doubles at 23 dB attenuation points (7% Full Scale)

***Reduced recording time can be achieved with reduced frequency range by a minimum-maximum frequency range limit selection.

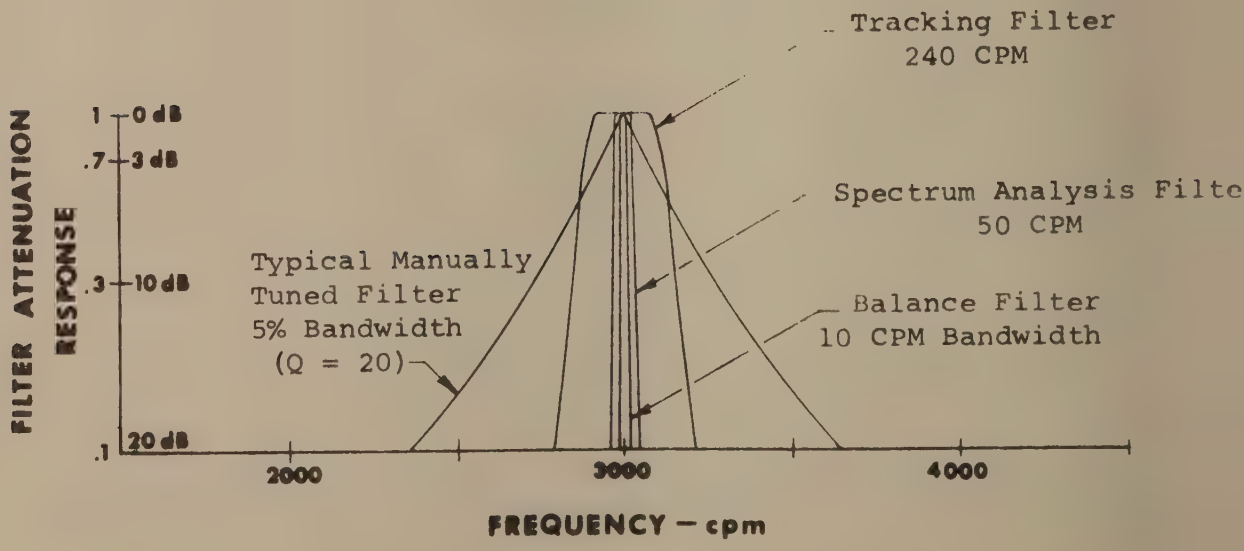


Figure 23. Filter Shape: Comparison with Typical Manually Tuned Filter

INPUTS

Two sensitivity dials allow instrument to be used directly with a large number of different transducers:

1) Velocity Pickups with sensitivities up to 1000 mV RMS/in/sec pk

2) Accelerometers with sensitivities up to 100 pc/g

3) Non-contact (proximity) pickups/ signal sensors with sensitivities up to 1000 mV RMS/Mil

4) Sound using Model 308 Vibration/ Sound Level Meter

5) Torsional vibration detectors with sensitivities up to 1000 mV RMS/ degree pk-pk

OUTPUTS

Balancing

Meter: Amplitude, Frequency, Phase

Tracking

Meter: Amplitude, Frequency, Phase

XY_1Y_2 Recorder: Amplitude and Phase vs. Frequency. Recorder ordinate (Y) scale display 0° to 360° phase, and either linear or log amplitude.

Variable Oscillator: Sinusoidal signal to drive power amplifier of electro-magnetic shaker for mode shape studies.

Spectrum Analysis

Meter: Amplitude, Frequency

XY Recorder: Amplitude vs. Frequency. Recorder ordinate (Y) scale display linear or log amplitude.

Filter Out

Meter: Amplitude, Frequency, Scope Output Jack

OPERATING TEMPERATURE	32° to 130°F (0° to 54°C)
SIZE (Instrument)	15-1/2 W x 7-1/2 H x 20-5/8 D in. (39.4 W x 19 H x 52.5 D cm.)
SIZE (Carrying Case for Accessories)	14-3/4 W x 13-3/4 H x 7-3/4 D in. (37.5 W x 34.8 H x 19.7 cm.)
NET WEIGHT (Instrument)	29 pounds (13.2 kilos)
NET WEIGHT (Standard Accessories in Carrying Case)	11 pounds (5 kilos)
SHIPPING WEIGHT (Instrument and Standard Accessories in Carrying Case)	50 pounds (22.8 kilos)
POWER	105-129 volts, 50-400 Hz, 35 watts (optional 210/258 volts) AC
STANDARD ACCESSORIES	• Electromagnetic Reference Pickup, Part No. 5106 • 25' Reference Pickup Cable, Part No. 9557 with Adapter Cable, Part No. 9556 (for use with either Part No. 5106 or optional Part No. 5262) • Model 544 Velocity Pickup, Part No. 4526 • Straight Probe, Part No. 1103 • 25' Cable (for Velocity Pickup) Part No. 10393 • 8' Power Cable with Adapter, Part No. 2914 • Accessories Carrying Case, Part No. 9490

OPTIONAL ACCESSORIES

- Photoelectric Reference Pickup, Part No.5262
- Universal Mounting Fixture, including Vice Grips,Part No.5920
- Magnetic Pickup Holder,Part N.4332
- Vice Grips.Part No.1821
- X-Y Recorder,Part No.12052
- X-Y_1 Y_2 Recorder,Part No.9787
- Vibration/Sound Level Meter,Model 308
- Non-contact Displacement Accessory, Part No.9252
- Model 910 Accelerometer,Part No.9641, see Note
- 25-Ft.Acceleromener Cable,Part No.10174

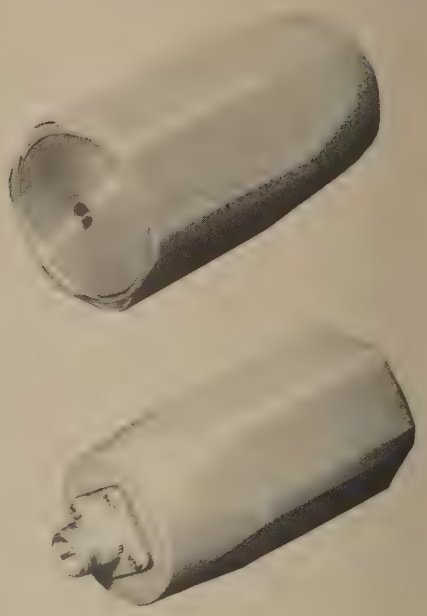
NOTE: Accelerometer cable 10174 must be used with the Model 910 Accelerometer.

SPECTFICATIONS ARE SUBJECT TO CHANGE WITHOUT NOTICE

MECHANALYSIS

VIBRATION PICKUP P/N 4526

MODEL 544

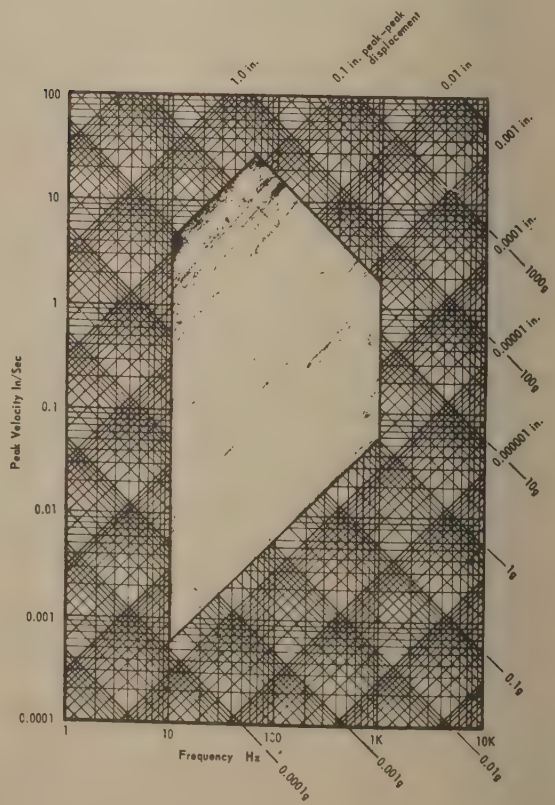


DESCRIPTION

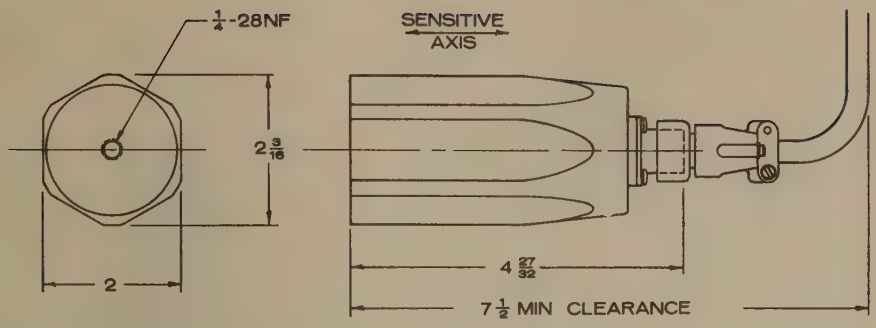
The Mechanalysis Model 544 Vibration Pickup is a seismic velocity transducer, consisting of a moving coil in a permanent magnetic field, with eddy-current damping. This pickup is suitable for a wide variety of manual and continuous monitoring applications due to its high output, low impedance wide frequency response, and rugged construction. The anodized aluminum housing is waterproof, dustproof, and acceptable for use in Division 2 hazardous areas. A variety of accessories are available.

SPECIFICATIONS

Frequency Range:	12 Hz - 1000 Hz ± 8%
Sensitivity:	764 ± 10% Mv RMS/in/sec (peak)
Temperature Range:	-40°F to +500°F
Impedance:	R = 2Kohms; L = 0.7 Hy
Damping Factor:	0.7 (critical)
Orientation:	Any
Transverse Response:	Less than 5% (average) between 10 Hz and 1000 Hz
Magnetic Field Sensitivity:	0.15 inches/sec/gauss
Housing:	Waterproof, dustproof
Connector:	2-pin 732S-10SL-4P
Weight:	21 oz
Grounding:	Case and signal ground common
Mounting:	1/4 - 28 tapped hole, 1/4 deep
Max Amplitudes:	125 mils pk-pk to 70 Hz; 30g above 70 Hz



OUTLINE DIMENSIONS



INSTALLATION NOTES

1. Sensitive axis may be oriented in any direction
2. Mounting surface must be flat, smooth, at least 2 3/8 in. dia.
3. Mounting stud axis must be perpendicular to mounting surface
4. Pickup should be installed hand-tight
5. Connector pin A is signal ground and housing ground; pin B is signal.
6. Mating cable connector is P/N 4366 (order separately).

ACCESSORIES (see Spec Sheets for detailed information)

1. Magnetic Shields - to reduce sensitivity to A.C Magnetic Fields by 10:1 or 100:1 P/N 1157, P/N 3563 (See Spec Sheet 43-02)
2. Explosion-proof Enclosure - for installations in Division 1 Class I, Group D or Class II Groups E, F, G Hazardous Areas P/N 4224 (See Spec Sheet 72-01)
3. Safety Barrier - for intrinsically safe installations in Division 1, Class I, Groups B, C, D Hazardous Areas P/N 7685 (See Spec Sheet 43-03)
4. Insulating Blocks - to insulate the pickup from mounting surface as required in some installations to eliminate ground currents and when bearings are insulated (See Spec Sheet 43-01)

IRD MECHANALYSIS

VIBRATION PICKUP (ACCELEROMETER) P/N 9641

MODEL 910

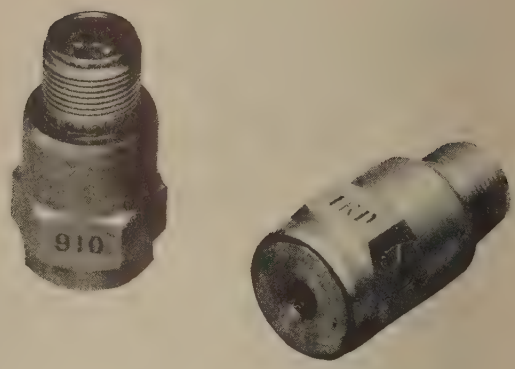
DESCRIPTION

The IRD Model 910 is a small, lightweight, rugged, accelerometer type vibration pickup for use with IRD equipment for the measurement, analysis and monitoring of machinery condition as well as for dynamic balancing.

The Model 910 is a self-generating, piezoelectric transducer which converts a machine's vibration into an electrical signal proportional to acceleration. Pickup performance is unaffected by critical environmental conditions such as moisture, magnetic fields and high temperatures.

A single ¼-28 mounting stud is used for attaching the pickup to a flat machine surface. Where significant ground potential may be present between the pickup mounting surface and the associated electronic equipment, an Insulated Mounting Stud is available to prevent false readings caused by ground loops. Other means of attaching the pickup, such as a magnetic holder or a hand-held probe may be used to facilitate periodic checks and temporary manual monitoring.

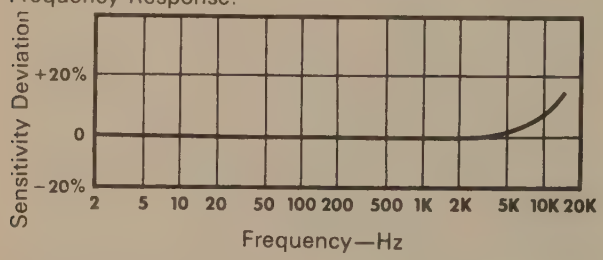
Low noise, high temperature, teflon (TFE) cross wrapped cable assemblies are available in standard lengths up to 100 feet. Longer cables up to 2,000 feet can be used without affecting response.



SPECIFICATIONS

Sensitivity: 15 pC/g Nominal

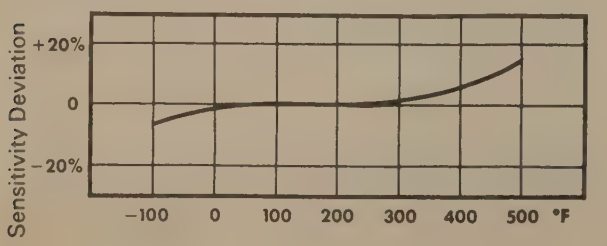
Frequency Response:



Mounted Frequency Response: 40K Hz Minimum

Maximum Amplitude: 2000 peak g, sinusoidal

Temperature Response:



Capacity: 2500 pf Nominal

Orientation: Any

Transverse Response: 5% Maximum, 3% Typical

Magnetic Field Sensitivity: Less than 10^{-4}g (equivalent) per Gauss

Grounding: Case isolated from signal ground

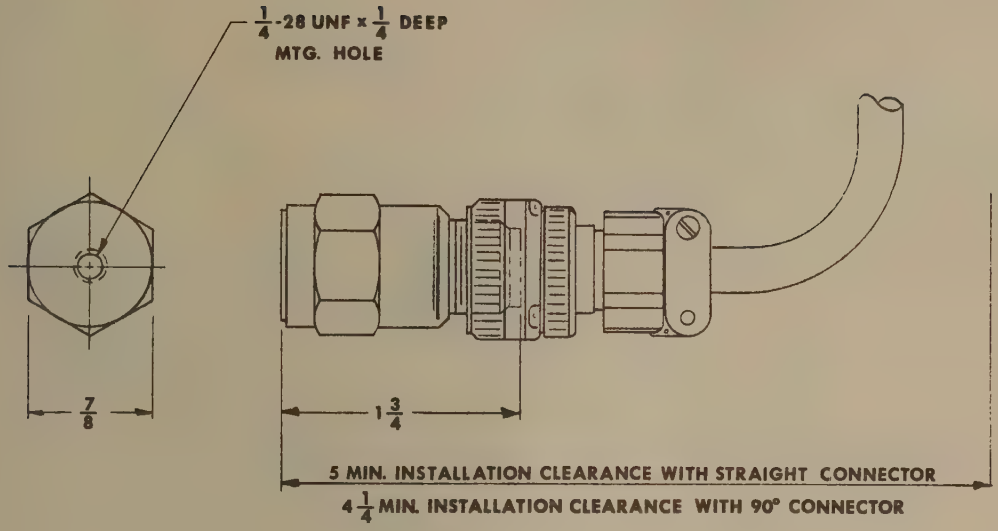
Housing: 300 series stainless steel, waterproof, dustproof, epoxy sealed

Connector: 2-pins, MS Type 10SL-4P

Weight: 2 ounces (57 grams)

Mounting: ¼-28 Tapped Hole, ¼" deep

OUTLINE DRAWING


1/4-28 UNF x 1/4 DEEP
MTG. HOLE
7/8
1 3/4
5 MIN. INSTALLATION CLEARANCE WITH STRAIGHT CONNECTOR
4 1/4 MIN. INSTALLATION CLEARANCE WITH 90° CONNECTOR

INSTALLATION NOTES

1. Mounting surface must be flat and smooth; mounting stud must be square with surface and must not exceed ¼ length.

2. Install with light coating of silicone grease on mating surfaces; tighten to 30-50 inch-pounds torque.

3. Connector Pin A is signal ground (insulated from case); Pin B is signal. Connector shell is connected to case.

ACCESSORIES

1. Low Noise Cable Assemblies (See Spec Sheet 42-04)

2. Insulated Mounting Stud (See Spec Sheet 43-08)

DESCRIPTION

The IRD low noise cable assemblies for Model 910 Vibration Pickups will withstand heavy industrial usage and rough service. The cables are specially treated to minimize the generation of electrical noise from vibration or flexing

Cable assemblies connect directly to IRD Model 350N and Model 360 Analyzers, and to other IRD Portable Equipment through the Accelerometer Amplifier (P/N 10312). Cable assemblies are also available for connection to the Accelerometer Preamplifier, P/N 9693, for use with Unicel and Series 6100 Monitors Each of these cables may be furnished with either 400° or 500°F straight connectors, or 250°F right angle connectors

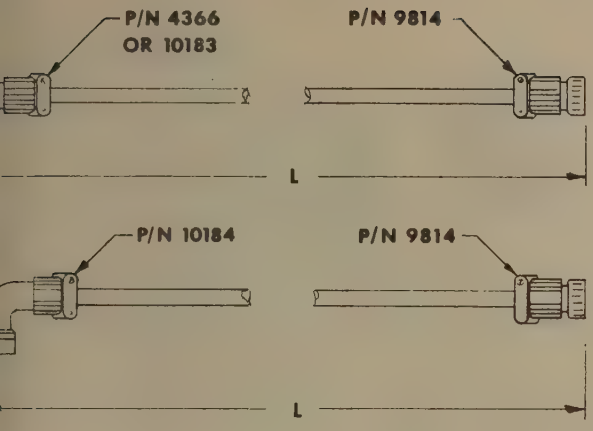
SPECIFICATIONS

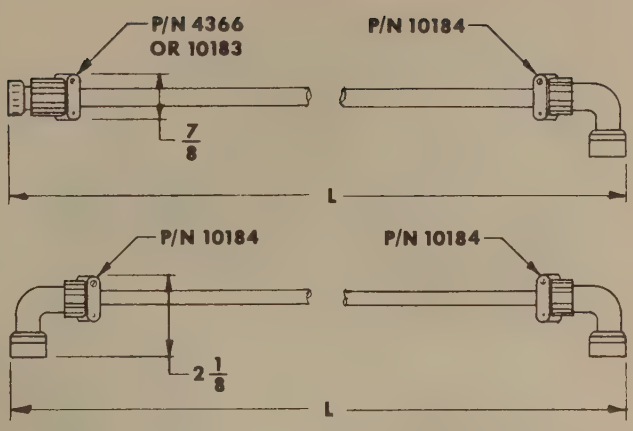
Cable	
Outside Diameter:	0.190 in. nominal
Conductors:	(2) AWG 20 (19x32), Silver Plated Copper
Insulation:	Teflon (TFE)
Jacket Material	Teflon (TFE) cross wrapped
Shield:	38 AWG Nickel Plated Copper, 90% Coverage

Voltage Rating:	1000 V RMS
Temperature Range.	—100°F to +500°F (—73°C to +260°C)
Leakage Resistance: —100°F to —500°F	200 meg ohm/ft. minimum
Capacitance:	
Conductor to Conductor	70 pF/ft
Conductor to Shield	140 pF/ft

It is recommended that cable assemblies be used wherever possible instead of bulk cable, since special precautions must be followed in connector attachment. (Standard cable assemblies are listed on the reverse side)

OUTLINE DIMENSIONS





1. Cable assemblies for use with Models 350N and 360 analyzers, and Accelerometer Amplifier, Part #10312

Part No.	Length Ft.	Connector Pickup End	Connector Analyzer End
10224	25	P/N 10183, Straight, 500°F	P/N 9814
9845	50	P/N 10183, Straight, 500°F	P/N 9814
10173	15	P/N 4366, Straight, 400°F	P/N 9814
10174	25	P/N 4366, Straight, 400°F	P/N 9814
10350	50	P/N 4366, Straight, 400°F	P/N 9814
10176	75	P/N 4366, Straight, 400°F	P/N 9814
10177	100	P/N 4366, Straight, 400°F	P/N 9814
10320	15	P/N 10184, Right Angle, 250°F	P/N 9814
10349	50	P/N 10184, Right Angle, 250°F	P/N 9814

2. Cable assemblies for use with Accelerometer Preamplifier, P/N 9693, Spec Sheet #62-06

Part No.	Length Ft.	Connector Pickup End	Connector Preamplifier End
10181	15	P/N 4366, 400°F, Straight	P/N 10184, Right Angle
10122	25	P/N 4366, 400°F, Straight	P/N 10184, Right Angle
10326	50	P/N 4366, 400°F, Straight	P/N 10184, Right Angle
10327	75	P/N 4366, 400°F, Straight	P/N 10184, Right Angle
10328	100	P/N 4366, 400°F, Straight	P/N 10184, Right Angle
10182	15	P/N 10183, 500°F Straight	P/N 10184, Right Angle
10318	15	P/N 10184, 250° Right Angle	P/N 10184, Right Angle

Special lengths up to 100 feet can be furnished on request. Longer cable lengths available on special order only.

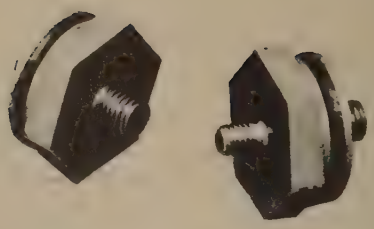
ORDERING INFORMATION

(Qty) P/N_____ , _____ ft. Cable Assembly

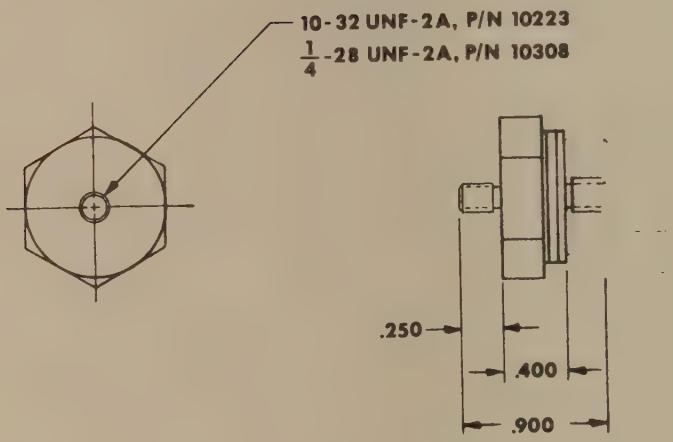
DESCRIPTION

Insulated Mounting Studs are recommended where a significant ground potential is present or could occur between the pickup mounting surface and the associated electronics. Their use prevents false readings caused by ground loops

The Insulated Mounting Stud provides single point mounting of the vibration pickup. The ¼-28 threaded stud in the top plate mates with the tapped mounting hole in the pickup A similar stud (either 10-32 or ¼-28) is provided in the bottom plate for attaching to the mounting surface. Mounting Studs are recommended primarily for temporary monitoring or for periodic measurements; maximum temperature limitation is 300°F



OUTLINE DRAWING



ORDERING INFORMATION

(Qty) P/N 10223 Insulated Mounting Stud, with 10-32 Mounting Stud

(Qty) P/N 10308 Insulated Mounting Stud, with ¼-28 Mounting Stud

DESCRIPTION

IRD Magnetic Holders provide a fast, effective method for temporary mounting of accelerometers.

The smaller 4-pole Magnetic Holder, Part No. 10406, has a holding force of 16 lbs. and has a permanently attached ¼-28 stud for attaching the accelerometer.

The larger 6-pole Holder, Part No. 10101, has a holding force of 25 lbs. and has a ¼-28 threaded bushing. The accelerometer may be attached with a stud (provided) or if electrical insulation is required, with a Part No. 10308 Insulated Stud

SPECIFICATIONS

	P/N 10406	P/N 10101
Holding force (on smooth, flat steel surface):	16 Lb.	25 Lb
Maximum Vibration Level:		
With Model 910 Accelerometer	100 g	150 g
With 960 Accelerometer	65 g	100 g
Diameter	1 in.	1 $\frac{1}{32}$ in.
Length	¾ in.	¾ in
Accelerometer Mounting	¼-28x¼ Long Stud	¼-28x⅜ Deep Threaded Hole

ADDENDUM

REFERENCE PICKUP INSTALLATION

Two reference pickups are available to provide the Model 360 the required reference signals. Each has its advantages for application under different conditions. They are listed in Table I.

TABLE I

REFERENCE PICKUP TYPE	RECOMMENDED USE
Electromagnetic - Part No. 5106	General purpose on magnetic materials from 600 RPM and up
Photoelectric - Part No. 5262	Low speeds - on reflective surfaces from 150 to 500,000 RPM

ELECTROMAGNETIC PICKUP

The Electromagnetic Reference Pickup is usable over a wide range of speeds and is provided as the standard reference pickup. The Electromagnetic Pickup generates a voltage output when any protrusion of ferromagnetic material with sufficient speed enters the magnetic field surrounding the pole piece at the sensing end of the pickup. Ferromagnetic materials include most steels and steel alloys from which shafts are made. Nonmagnetic shafts require the addition of a ferromagnetic protrusion.

Four factors determine the voltage output of the pickup.

1. Velocity of the interrupting metal protrusions.
2. Mass or size of the protrusion.
3. Magnetic properties of the protrusion.
4. Distance from pickup to protrusion.

The Electromagnetic Pickup (Part No.5106) produces a 3-volts peak-to-peak output signal when installed in the configuration shown in Figure 24. Velocity of a 1/4 by 1/4-inch protrusion is approximately 250 inches per second. The gap or distance from the pole piece to the protrusion in Figure 24 is 0.020 inch.

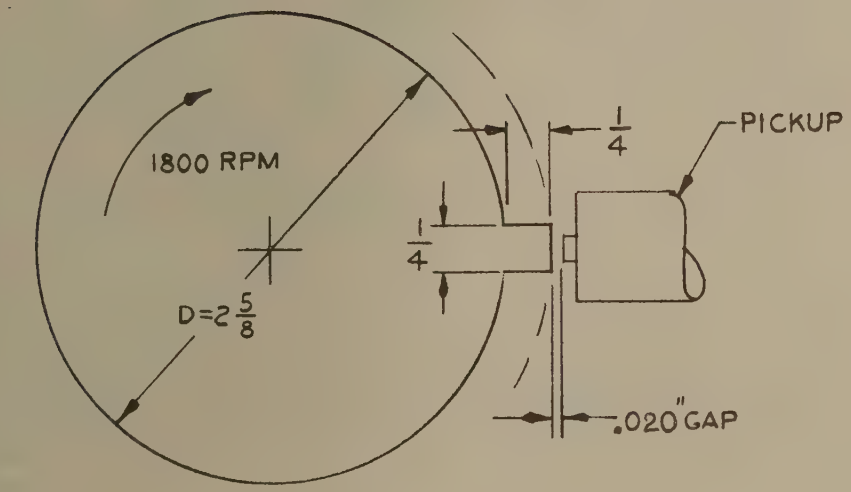


Figure 24 Installation Diagram for the Electromagnetic Reference Pickup

Doubling the shaft velocity also doubles the pickup output voltage. Thus, decreasing the velocity reduces the output voltage proportionally. Since the minimum output value required in the reference signal is 0.6 volt peak-to-peak, the low speed limit is approximately 50 inches/second. For the 2-5/8 inches shaft in Figure 24, the low-speed limit is approximately 360 RPM. When ideal conditions exist in all other installation factors of the pickup, the low limit needed for producing an adequate amount of signal voltage is 50 inches per second of shaft protrusion velosity. The Electromagnetic Pickup, as shown in Figure 24 with the .0.020-inch gap, outputs approximately 0.012 volt per inch per second.

Protrusion velocity may be computed as follows:

V = Protrusion velocity in inches/second

RPM = Rotating speed of shaft in revolutions per minute

D = Shaft diameter in inches

= 3.14

$$V = D \frac{RPM}{60} = .0524\ D \times RPM$$

Multiply protrusion velocity by .012 to determine peak-to-peak voltage output for a .020" gap. If gap is larger, use curve in Figure 27 to adjust the output voltage. 0.6 volts peak-to-peak is normally required for good reference pulses.

The protrusion in Figure 24 is shown as 1/4" high by 1/4" wide. The diameter of the pole piece of the pickup is .106". See Figure 25. Thus, the protrusion is slightly more than twice as wide, in the direction of rotation, as the pole piece. As a general rule, the protrusion should be at least as wide as the pole piece, i.e., the protrusion should be at least 1/8" wide and 1/8" long. The height of the protrusion should be at least 1/8". One quarter inch is preferred. Actually, the greater the height the better.

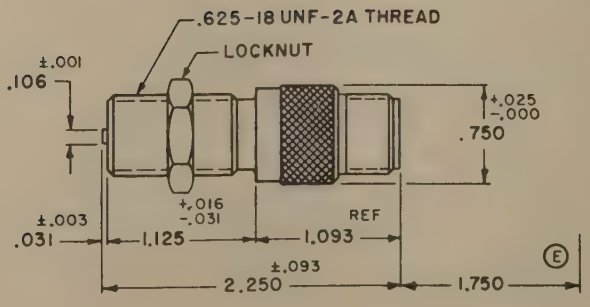


Figure 25.
Electromagnetic Pickup Dimensions

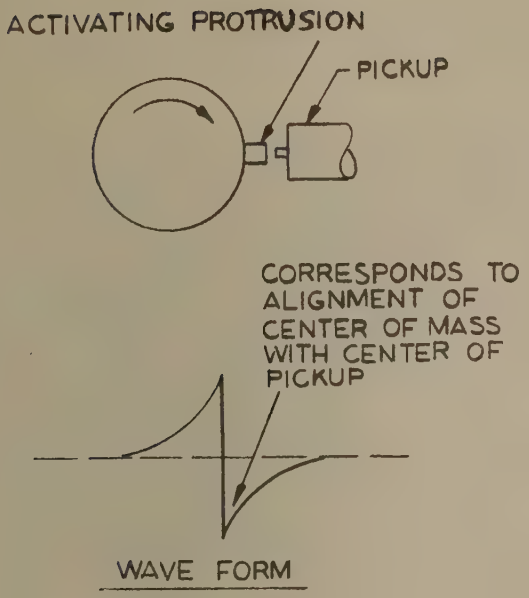


Figure 26 Reference Signal Waveform

The most important single factor in preparing the protrusion is its shape. To provide a clean-sharp reference signal voltage,the protrusion must also be clean and sharp.The material from which the protrusion is fabricated must be clean,smooth,and free from rust or scale. The edges must be broken sharply. Ideally, the protrusion should be formed similiar to the one illustrated in Figure 24. However, any protrusion that produces a reference signal (once per RPM) similiar in shape to the waveform illustrated in Figure 26 is satisfactory. The shape of the reference signal waveform can be determined by viewing it on an oscilliscope. A signal whose waveform is jagged at or near the base is generally unsatisfactory. Roughness, dirt, or rust at the top of the protrusion or pole piece of the reference pickup can cause a jagged waveform and,thus, improper operation.Fine adjustment of the Reference Adjust control can eliminate the effects caused by some surface roughness.

NOTE: The reference signal waveform can be observed by applying the pickup output voltage to an oscilliscope. On the pickup, Pin B is the high side of the signal, and Pin A is the ground side.

A hole or depression may be used instead of a protrusion. A clean 1/4" to 3/8" diameter hole 1/4" deep may be used with confidence.

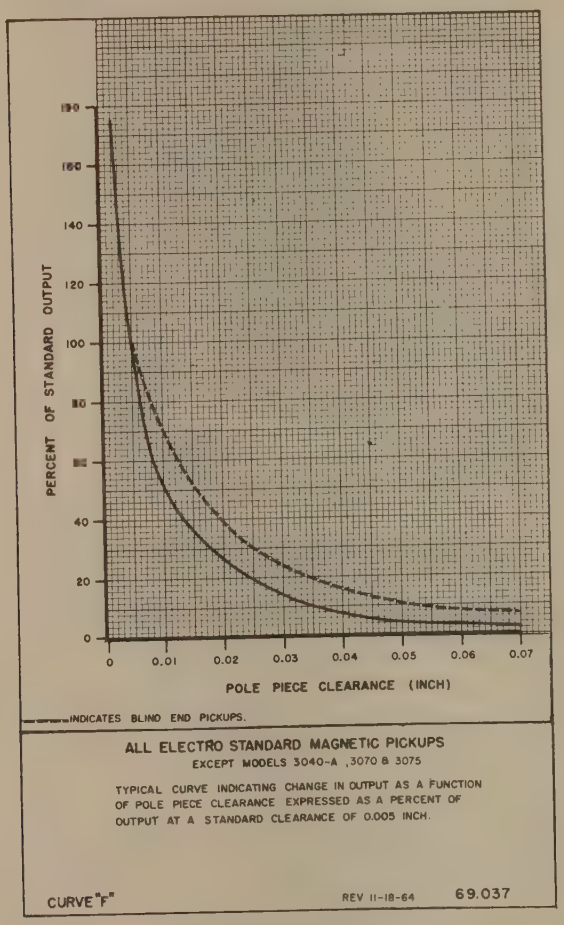


Figure 27.
Output vs. Clearance or Gap

A clean, undamaged keyway with sharp corners may also be used with confidence. The keyway should be at least 1/8" deep and 1/4" to 3/8" wide.

Ordinary screw or bolt heads should not be used without first grinding or filing them smooth and flat on top with 90° corners in the direction of rotation. The true test of any reference pickup installation is a steady frequency and phase reading on the meters of the 360 as the machine operates.

There is one final factor affecting the reference pickup installation; that is, the gap between the reference pickup pole piece and the protrusion. This gap should be .020" at slow speeds. Greater gap distances to .100" may be used at high speeds. Actually, the voltage output from the pickup decreases rapidly with increased gap as shown in Figure 27. Gap is, of course, most important at the slow speeds.

Mounting the Electromagnetic Reference Pickup

The preceding has outlined the basic requirements for a suitable Electromagnetic Reference Pickup signal. Locating the reference pickup next to the protrusion can be accomplished in several ways. The first would be to prepare a special mounting bracket suitable to the machine to be studied. Figure 25 shows the basic dimensions of the pickup. Two locknuts are provided instead of the one shown. Spark plug gauges may be used to set the gap for the pickup.

Figure 28 shows the reference pickup mounted using the vise grips and the Universal Mounting Fixture. The fixture consists of three 1/2" diameter rods, 12", 9", and 6" long; a reference pickup mounting plate and two adjustable Universal joints. The 6" rod has a 1/4"-28NF threaded hole for attaching the fixture to the vise grips. The reference pickup mounting plate has a 5/8"-18NF threaded hole for attaching the electromagnetic reference pickup. When the optional photoelectric reference pickup is supplied, a mounting plate with 25/32" hole is also provided. Thus, the fixture can be used to mount either the electromagnetic or the photoelectric reference pickup.

PROPER REFERENCE PICKUP TRIGGERING OF THE MODEL 360 IS EVIDENCED BY A STEADY READING ON THE FREQUENCY AND PHASE METER OF THE INSTRUMENT WHEN THE MACHINE BEING TESTED IS OPERATING.

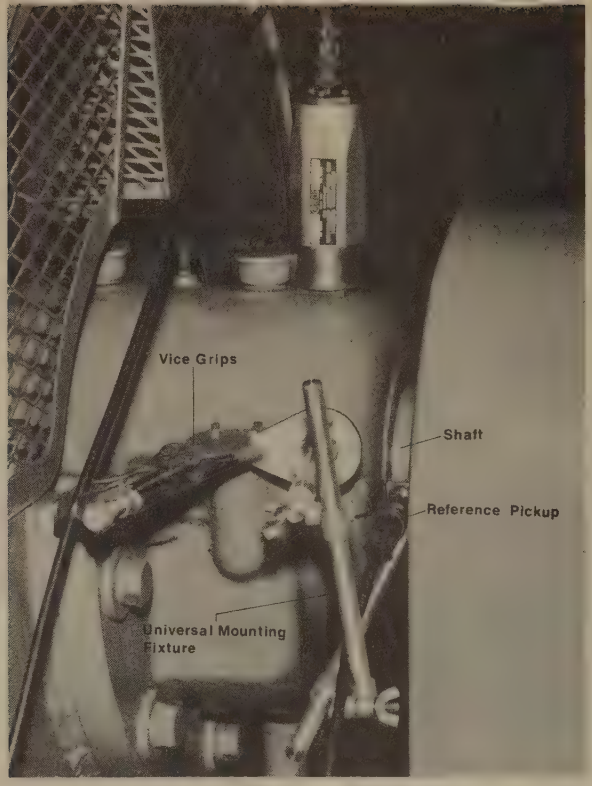


Figure 28. Reference Pickup Mounting

Because of the small gap required for a good signal with the electromagnetic pickup, there is danger that the protrusion may strike the pickup. It is suggested the pickup be placed within about 1/8" of the protrusion while the machine is at rest. Start the machine and observe for proper reference pickup triggering (steady readings). If required, advance the pickup by screwing it into the bracket. The pickup will advance about .055" per turn. When a suitable reference pulse is obtained, be sure to lock the pickup in place using the locknuts provided. You will find that gaps larger than the ideal .020" will prove adequate on machines with large diameter shafts and RPMs above 1000 because the protrusion velocity will be high. You will also find that the electromagnetic pickup is very sensitive to even slight deviations from a smooth surface when the surface velocity is high. For this reason the Reference Adjust Control is provided.

NOTE

Only photoelectric pickups such as IRD Part No. 5262 (Power Instruments Model 836), or the equivalent should be used.

The input circuit is protected by Zener diodes. The input impedance of the circuit is 50k ohms until the Zener breakdown voltage of ± 90 volts peak is exceeded. After Zener breakdown the input impedance is greatly reduced. This should be taken into consideration if tachometer generators with very large outputs are used as reference sources. Excessive input current may damage the tachometer generator or input circuit or both. For tachometer generators that have outputs exceeding 90 volts peak, a resistor of approximately 100K ohms in series with the input signal lead will provide the current protection needed. Electromagnetic pickup outputs that exceed 90 volts peak will not damage the input circuit as these pickups cannot produce large current outputs. However, to provide added circuit protection electromagnetic pickups may be spaced further from the rotating surface projection to reduce their output.

To unlock the micrometer dial, raise the lock lever; when the correct setting is found, lock the control by lowering the lever. The micrometer dial controls a ten-turn potentiometer. The number in the dial window is a whole number and the dial skirt number is a decimal. Example: a reading of 6 in the dial window and 38 on the dial skirt is read as 6.38. The dial permits selectable triggering on the desired portion of a distorted waveform; see Figure 28A. The input waveform is a a-c coupled and a dial reading of 5.00 indicates that the instrument will trigger at zero crossings of the waveform. A dial setting of just above 5.00 to up to 10.00 triggers the instrument on the positive portion of the waveform; a setting of 0.00 to just below 5.00 permits triggering on the negative portion.

Proper triggering (and hence proper dial setting) is indicated by steady readings on the frequency and phase meters.

Usually the best procedure for setting the REFERENCE ADJUST Control for correct triggering from a magnetic reference pickup, is to start at 5.0 and increase the dial setting above 5 until it is above the noise as indicated by steadier meter readings. (See Figure 28A; the line above line "1".) Continue to increase the dial setting until unsteady readings occur due to occasional lack of trigger amplitude or due to a false trigger which causes an additional "zero crossing" as illustrated by line "2", dial setting 7.0. Adjust the control to a setting midway between these two extremes as illustrated by line "4", dial setting 5.7. Thus, even though the noise level or the false trigger varies in amplitude, neither will cause additional "zero crossings" and steady meter readings result. However, if this is not the case, increase the dial to midway between the false trigger level and peak trigger fluctuation points as indicated by line "3" and dial setting of 8.0 to obtain steady readings.

Generally when the photoelectric reference pickup is used, a steadier trigger is obtained by starting the dial setting at 5.0 and decreasing the dial setting in the negative region.

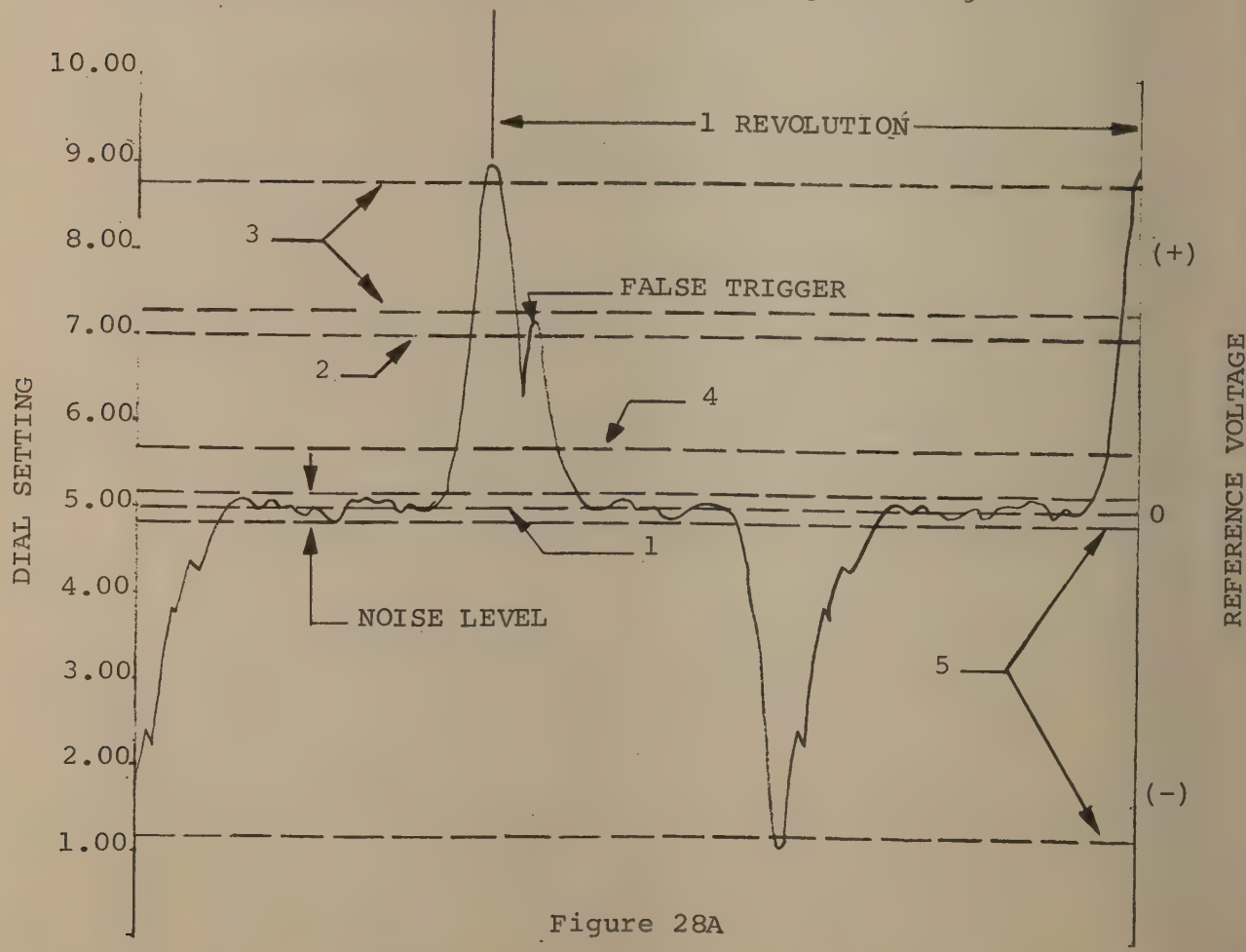


Figure 28A

The "noise" in the reference signal may be attenuated (reduced) by adjusting the Reference Adjust Control. You will know this is required if the wrong frequency or unsteady frequency and phase readings exist. If this action does not produce proper meter readings, inspect the reference pickup installation.

> CAUTION: Occasionally the vibration occurring at shaft speed frequency is not steady state. This will give the same indication on the meters as a poor reference pickup signal. When you suspect such a condition, disconnect the vibration pickup. An unsteady frequency or phase meter reading positively identifies a poor reference signal.

Photoelectric Reference Pickup

If the optional Photoelectric Reference Pickup is used, the shaft must have a reflective surface covering 5 to 25% of the circumference. The remainder of the shaft circumference must have a dull, nonreflective surface. The shaft may be prepared to meet these requirements with a can of flat black spray paint to provide the full, nonreflective surface. A strip of white, glossy surfaced tape may be used as the reflective surface. This strip of white must reflect light well without diffusion. Glossy white paint may also be used. For fast speeds the white reflective surface should cover at least 20% of the circumference. For slower speeds less white surface is required.

Spacing between the shaft and the Photoelectric Reference Pickup can vary from 1/4" to 3". Spacing of the photoelectric reference pickup is not as critical as is the alignment of the pickup with the reflective surface. Proper alignment for the best reference signal is obtained by operating the machine and observing the frequency on the 360 Amplitude Frequency Meter. If the meter provides a steady frequency indication the reference signal is adequate. If the frequency indication is not steady, rotate the reference pickup in its brackets to obtain the maximum reflection of light into the photocell. This photocell provides its own light source. If ambient light is strong, then the photoelectric reference pickup may be shielded to obtain a better signal. Be sure the lens is clean.

MODEL 544 VIBRATION PICKUP, ATTACHMENT METHODS

There are several methods which can be used to attach the Model 544 Velocity Pickup. These include: hand-held with probe, hand-held without probe, stud mounting, vise-grip pliers and magnetic pickup holder. Each of these methods will hold the pickup in place without distorting the actual mechanical vibration, but only over a limited frequency range. The table below gives for each type of mounting the highest frequency for which errors due to mounting method are less than ±8%. Vibration readings taken at higher frequencies will, of course, be subject to greater error. In this connection, care should be exercised in making overall (i.e., Filter Out) measurements that the measured level is not caused by a frequency above the frequency range allowed by the pickup attachment method.

Pickup Mounting Method	Maximum Frequency*
Vise-grip pliers	7,200 CPM
Hand-held with 9" probe	16,000 CPM
Hand-held with 3" probe	18,000 CPM
Magnetic pickup holder	37,000 CPM
Hand-held without probe	60,000 CPM
Stud mounting	60,000 CPM

*These represent maximum frequencies based upon careful mounting practice. When less than good mounting conditions exist (e.g., uneven surface, painted surface, etc.) these frequencies may be reduced.

When mounting the pickup, any object used between the pickup and the measured surface (e.g., insulated stud, bracket, adapter, as well as the probe, magnetic holder, etc.) will affect the maximum allowable frequency of measurement. It is the inherent stiffness of the object between pickup and vibration surface that is the major factor. Those with high stiffness (e.g., solid block of steel) allow a relatively high maximum frequency of measurement, while those with low stiffness (e.g., soft composition insulator, or long slender probe) allow only a low maximum frequency.

Stud Mounting

By far the best and most reliable mounting technique is to fasten the pickup directly to the measured surface with a 1/4-28 x 1/4" stud. The stud may be fastened to the surface by drilling and tapping a 1/4-28 hole or by welding or brazing. The mounting surface should be flat, with the entire face of the pickup in contact with the surface. The stud must be square with the mounting surface. A thin coating of silicone grease on the threads and mating surfaces is recommended to improve coupling where sensitivity and accuracy are of utmost concern.

The stud length must not exceed 1/4" to prevent bottoming-out in the end cap of the pickup. Tests show that mounting the pickup with an overly long stud may reduce the maximum allowable frequency range 40 to 50%, and damage end cap seal.

Hand-Held Without Probe

The hand-held pickup without probe is generally quite satisfactory for most periodic vibration checks and for most vibration analysis applications. As with stud mounting, the pickup should be held against a reasonably flat surface with the entire face of the pickup in contact with the measured surface. When applying the pickup to curved or irregular surfaces, keep in mind that the pickup measures vibration only in the direction parallel to the pickup axis, and that any unsteadiness of the hand which allows the direction of the axis to vary may result in unsteady vibration reading.

Use only enough pressure to keep the pickup from chattering or "walking" on the surface. When the vibration pickup is hand-held, a tingling sensation in the hand indicates the presence of a high frequency vibration and the need for more pressure.

Hand-Held With Standard 9" Probe

The standard 9" probe furnished with all IRD vibration meters, selectors and analyzers, is a convenience device for reaching out-of-the-way points for measurement and to assist in locating the pickup at a specific point on the machine. The standard probe may be used for the majority of periodic check and analysis applications. Caution should be taken where vibration frequencies are above 16,000 CPM. Above 16,000 CPM it is suggested that the probe be removed for measurement. Enough

hand pressure must be applied to prevent the pickup from chattering. Any unsteadiness in holding the pickup which allows the axis of the pickup to change direction may produce incorrect readings.

Vise-Grip Pliers

The vise-grip pliers require a firm mounting, preferably with the jaws in contact with the mounting surface along their entire length. Actually, vise-grips are items of convenience for use during in-place balancing, and are not recommended for vibration analysis purposes because of their very limited usable frequency range.

Magnetic Pickup Holder

The magnetic pickup holder should be mounted on a reasonably flat, smooth, clean unpainted surface. A layer of paint or dirt between the magnet and the mounting surface reduces the holding power of the magnet and consequently the maximum allowable frequency range. If the magnetic surface is not flush with the mounting surface, the holder may rock at some unpredictable low frequency, producing erroneous readings. When properly applied, the magnetic holder produces good results as a vibration pickup holder.

Shaft Stick

The massive cases and relatively rigid bearings of high speed machines such as turbines, centrifugal pumps and compressors will often have very little vibration even though the rotor and shaft may be vibrating excessively within the clearances of the bearings. The "shaft stick" provides a convenient means of measuring shaft vibration for comparison with bearing cap vibrations.

The shaft stick is simply a hardwood, fish-tail shaped stick with a 1/4-28 x 1/4" stud for attaching the pickup. The fish-tail shape provides two points of contact needed to keep the shaft stick on the circumference of a rotating shaft, and also permits the use of the shaft stick with almost any diameter shaft or roll.

Since the shaft stick senses shaft out-of-round and other irregularities in geometry as a vibration, as well as the true shaft vibration, it may be worthwhile to make a check with a dial indicator.

Shafts must be reasonably smooth, preferable turned or ground. Applying the shaft stick to shafts with rust, dents, pits or an otherwise rough surface will not only produce useless information, but may also damage the stick. In addition, take care to avoid keys and keyways, set screws and lubrication holes, as these can be equally destructive to the shaft stick. For shaft speeds in excess of 3600 RPM, avoid holding the stick against the shaft for any length of time. Heat build-up from friction may burn the shaft stick or actually cause scoring of the shaft. Frequent applications of a medium weight lubricating oil is recommended to reduce friction and heat build-up on high speed shafts. Shaft stick readings are not recommended at shaft speeds above 12,000 RPM.

MODEL 910 VIBRATION PICKUP (ACCELEROMETER) ATTACHMENT METHODS

The rules which apply to the attachment of the Model 544 Velocity Pickup also apply, in general, to the Model 910 Accelerometer. Because of its small size and other differences in design, however, it can be used to significantly higher frequencies than the Model 544. Such maximum frequencies for different mounting conditions are given in the table below.

Pickup Mounting Method	Maximum Frequency*
Hand-held with 3" probe (without grease)	36,000 CPM
Hand-held with 3/4" probe (without grease)	54,000 CPM
Magnetic holder (without grease)	120,000 CPM
Magnetic holder	420,000 CPM
Hand-held without probe	420,000 CPM
Threaded insulated stud	420,000 CPM
Threaded stud	600,000 CPM

*These represent maximum frequencies based upon careful mounting practice, including use of light coating of grease, except where noted. When less than good mounting conditions exist (e.g., uneven surface, painted surface, etc.) these frequencies may be reduced.

In many cases the method of pickup attachment will not be critical. Such is the case for machines whose only significant vibrations are below the lowest maximum allowable frequency (i.e., 36,000 CPM), and whose overall level is less than 1 g peak. When, however, the significant frequencies of a machine are not known prior to measurement, the attachment method should be that which provides the highest maximum allowable frequency. This should be stud mounting, if possible, or hand-held without probe. For stud mounting a 30 to 50 in-lb torque is recommended to securely attach the accelerometer.

At vibration levels of 1 g peak and higher, it becomes increasingly difficult to make accurate hand-held measurements because of chatter of the pickup against the surface. Under such conditions, it is best to use stud mounting, or a magnetic holder.

Where high g levels are experienced (i.e., in the range of 10 to 30 g peak, or higher), stud mounting only should be used. Cementing the pickup to the surface with dental cement, or epoxy, is also satisfactory for high g levels; however, the maximum allowable frequency will vary depending upon the thickness of the bond and type cement. Under good mounting conditions this maximum can be in the range of 420,000 CPM.

CALIBRATION CHECK PROCEDURE

The objective of this procedure is to verify the input sensitivity calibration.

Set Up

Amplitude Range to 1 (30 on metric)
Pickup Selector to MILS (MICRONS on metric)
Frequency Range 600-6K CPM
Function to Track
Recorder to Operate
Reference Adjust to 4.0 to 6.0
Accel Sensitivity to 100 PC/g (fully clockwise, dial reading 000
Vel Sensitivity to 1000 MV RMS/IN/SEC PK (fully clockwise, dial reading 000)
Power ON

Velocity Pickup Input

Connect a signal generator to the three-pin Vibration Pickup input and Reference input.

Signal input Pin A is ground, B is signal. Refer to Figure 30.

Set signal generator frequency to 318 Hz and level to 1.0V RMS (1.18 on metric)

Amplitude reading should be full scale on 0 to 1 scale (0 to 3 scale on metric)

Switch Pickup Selector to IN/SEC. MM/SEC metric)

Amplitude reading should be full scale on 0 to 1 scale (0 to 3 scale on metric)

Disconnect the signal generator.

Accelerometer Pickup Input

Connect a shielded 1000 pC ±1% capacitor, e.g., General Radio 1403A, in series with the signal generator output to the 360 Vibration Pickup input. Pin A is ground, C is signal. Refer to Figure 29.

Switch Pickup Selector to g's.

Set signal generator frequency to 61 Hz (49.3 Hz on metric units) and level to 100 mV RMS at variable attenuator output.

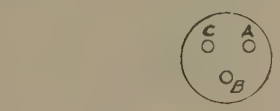
Amplitude reading should be full scale on 0 to 1 scale (0 to 1g scale on metric)

Switch Pickup Selector to ACCEL IN/SEC. (MM/SEC on metric)

Amplitude reading should be full scale on 0 to 1 scale (0 to 1g scale on metric)

Disconnect the signal input.

Accelerometer Input



A Ground
B Do Not Use
C Signal

Reference Input

1 Do Not Use
2 Do Not Use
3 Signal
4 Ground

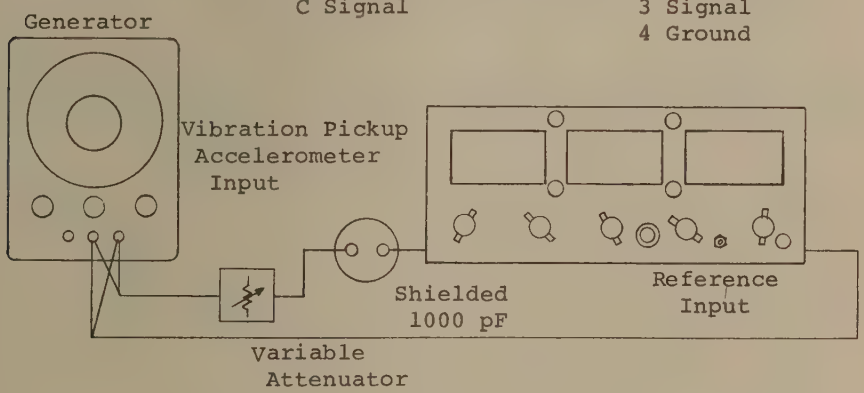


Figure 29.

Velocity Input

A Ground
B Signal
C Cable Shield

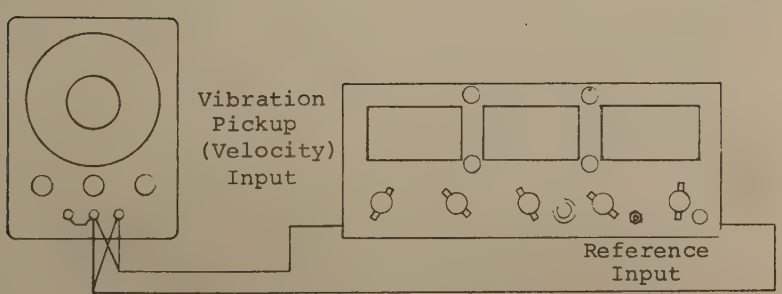


Figure 30.

INPUT MULTIPLIER NULL PROCEDURE

The objective of this procedure is to null the input multipliers with a minimum of test equipment.

CAUTION: Do not adjust R1291 or R1292 as this is a factory adjustment requiring extensive equipment and procedures.

Set Up

Frequency Range to 600-6K CPM
Function to Spectrum Analysis - Manual
Recorder to Operate
Adjust Manual Tune to 3000 CPM
Do not apply reference or vibration signals

Procedure for using a D.C. voltmeter

Use a voltmeter with a full scale range of 1 to 1.5V or less and a sensitivity of at least 20,000 ohms/volt.

Connect the D.C. voltmeter to case ground and TP1201 (green). See Figures 31 and 32.

If the reading is not 0 $\pm$10 mV, adjust R1294 for zero.

Move the test lead from TP1201 (green) to TP1202 (red).

If the reading is not 0 $\pm$10mV, adjust R1294 for zero.

Procedure for field nulling without a D.C. voltmeter

Observe the amplitude meter reading. Amplitude Range has no effect on this reading.

Alternately adjust R1293 and R1294 for the best null (zero reading).

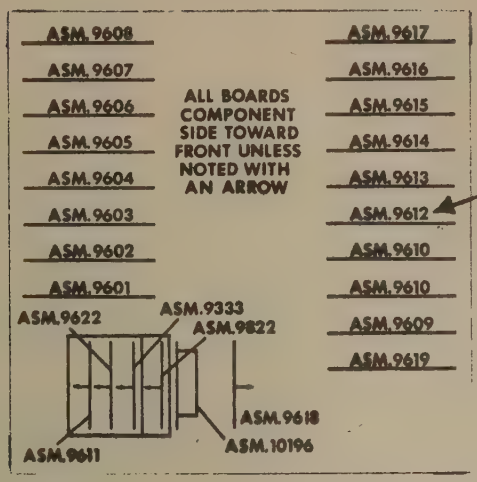


Figure 31. Printed Circuit Board Location

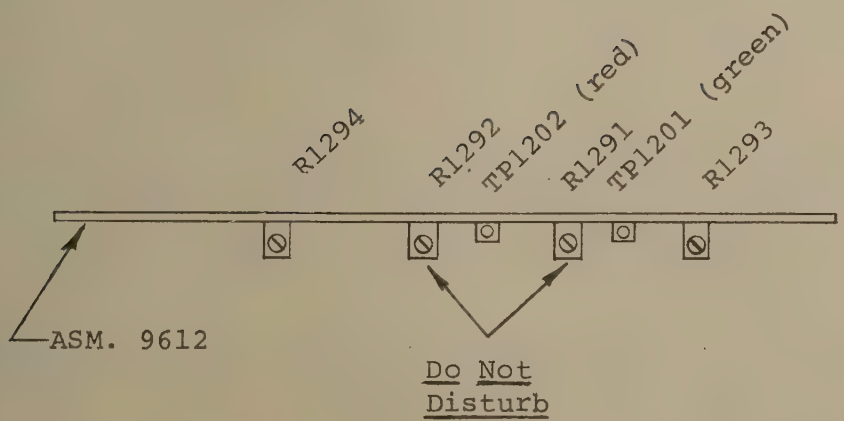


Figure 32.

USE OF SELF-POWERED STROB LIGHT AND EXTERNAL OSCILLATOR WITH THE MODEL 360

Strob Balancing

Although the Model 360 is designed for high precision balancing using an electromagnetic (or photocell) reference pickup in connection with the phase meter to provide accurate phase information, there may be occasion when it is desirable to use the strob for balancing. Use IRD Model SP585 Strob or equivalent. Note that the signal supplied to the strob is unfiltered.

Procedure:

1. Set up the Model 360 as if a Manual Spectrum Analysis was to be performed.

2. Place the Pickup Selector in the "MILS" (MICRONS on metric unit) position, and utilize a velocity pickup to sense the unbalance vibrations.

3. Place reference mark on shaft of machine to be balanced, or note a keyway, etc. which can be used as reference mark.

4. Connect the strob trigger cable to the Model 360 "FREQ OUT" receptacle.

5. Tune the Model 360 filter manually until the strob "freezes" the reference mark at rotational speed. The Model 360 filter is now precisely tuned to rotational speed. Adjust the Amplitude Range Selector for maximum on scale amplitude reading.

6. Switch the strob trigger cable to the "SCOPE" receptacle. The reference mark should remain frozen. If it does not, it indicates that there are too many interfering frequencies to use this strob balancing technique.

7. Note the reference mark phase angle in degrees with respect to an arbitrary fixed position such as the vibration pickup. Also note the vibration amplitude. These are the "original" balance readings.

8. Stop the machine; install a trial weight, and proceed as with conventional strob light balancing.

EXTERNAL OSCILLATOR TRACKING

An external oscillator connected to the "REFERENCE PICKUP" receptacle of the Model 360 can be utilized in two ways:

1. To provide precision frequency readout of individual vibration peaks, and

2. To provide a somewhat more rapid manual spectrum analysis of the three lowest frequency ranges (120-600, 600-6,000, 6,000-60,000)

Procedure for 1. above: "Precision Frequency Readout"

1. Set up the Model 360 for operation in the TRACK mode, but connect the Reference Pickup cable to a precision oscillator, rather than the reference pickup.

2. Connect a low frequency digital counter to the output of the oscillator.

3. Coarse tune the oscillator to the general frequency range of the vibration peak of interest, and then fine tune by "peaking" the amplitude meter.

4. Check the Phase Meter. It should be oscillating back and forth. This indicates a "beat" between the vibration signal and the oscillator signal. Continue to fine tune the oscillator until the phase meter reading becomes stationary. The oscillator is now exactly tuned to the vibration signal.

5. The frequency counter is now read to obtain the precise frequency of the vibration signal. The accuracy with which the vibration signal can be read depends upon its stability and the precision of the oscillator.

Procedure for 2. above: "Rapid Manual Spectrum Analysis"

1. Set up as for the previous procedure.

2. Set up the XY Recorder to cover the frequency range of interest, as is done when setting up to record an XY plot in the TRACK mode.

3. Set the oscillator at 120, 600 or 6000 CPM, depending upon the frequency range of interest.

4. Tune the oscillator through the frequency range of interest, being careful not to tune so fast that data is lost. Manually tuning with the oscillator requires some practice to develop a "feel" for proper tuning rates.

STROB VIBRATION PEAK IDENTIFICATION

The self powered strob can be used with the Model 360 to:

1. "Freeze" those machine components which are the cause of vibration peaks

2. Identify which vibration peaks are harmonics of shaft rotation

3. Conduct slow motion studies

Procedure:

A similar procedure is used for each of the above techniques.

1. Set up the Model 360 as if a Manual Spectrum Analysis was to be performed.

2. Connect the strob trigger cable to the Model 360 "REF OUT" receptacle.

3. Connect a low frequency counter to the Model 360 "FREQ OUT" receptacle. Note: The counter is not essential, but is useful in reading the individual vibration peaks with high accuracy.

4. To determine the mechanical source of a vibration peak displayed on a machine's vibration signature carefully tune the analyzer to that peak by adjusting the amplitude for maximum. Then take the strob light, which will be triggered at that peak vibration frequency, and scan the moving parts of the machine. The moving part causing that vibration will be "frozen" by the strob light.

5. To determine harmonics of the shaft rotational vibration, tune the analyzer until the motion of the shaft is "frozen" by the strob light at the frequency of its rotational speed. Mark the vibration peak (if any) on the vibration signature graph which occurs at this frequency. This is the first harmonic. Continue to tune the analyzer until the shaft again appears to be frozen. This is the second harmonic, and the associated peak (if any) on the vibration signature graph can be so marked. Higher harmonics can be identified in the same way.

6. For slow motion studies, the analyzer is tuned to the frequency of the vibrating part to be studied, and then slightly detuned so that the part appears to move slowly when illuminated by the strob light.

DESCRIPTIVE SPECIFICATIONS

MODEL SP585

STROB LIGHT

The Model SP585 Strob Light is a self-contained portable unit for use with IRD vibration meters and analyzers. It may be used for balancing, analysis, slow-motion studies and speed measurement.

The SP585 is connected to the oscilloscope output of analyzers, or the analyzer jack of monitors. The high-intensity strob will flash at each positive-going zero crossing of the input signal, up to a maximum flash rate of 5,000/minute. Above that speed, sub-multiple firing is used to extend bulb life.

An internal power supply operates from 105-129 volt AC power.

SPECIFICATIONS

Input	.03 to 30v RMS; adjustable sensitivity control.
Input Connections	5-ft. Cable with BNC connector.
Frequency Range	10-5000 CPM direct firing 5000-500,000 CPM sub-multiple firi
Phase	Flash occurs at positive-going zer crossing.
Beam	Approximately 24" dia. beam at 10
Power	105-129v 50/60Hz (may be wired for 210-258v); Power switch and 8 ft. power cable provided.
Fuse	0.5 AMP
Size	8.5L x 5W x 4H (inches) 21.6L x 12.9W x 10.1H (centimeters
Weight	5 lb. (2.3 Kg) net 10 lb. (4.6 Kg) shipping

2/1/74: Subject to change without notice.
Revised 3/6/74.

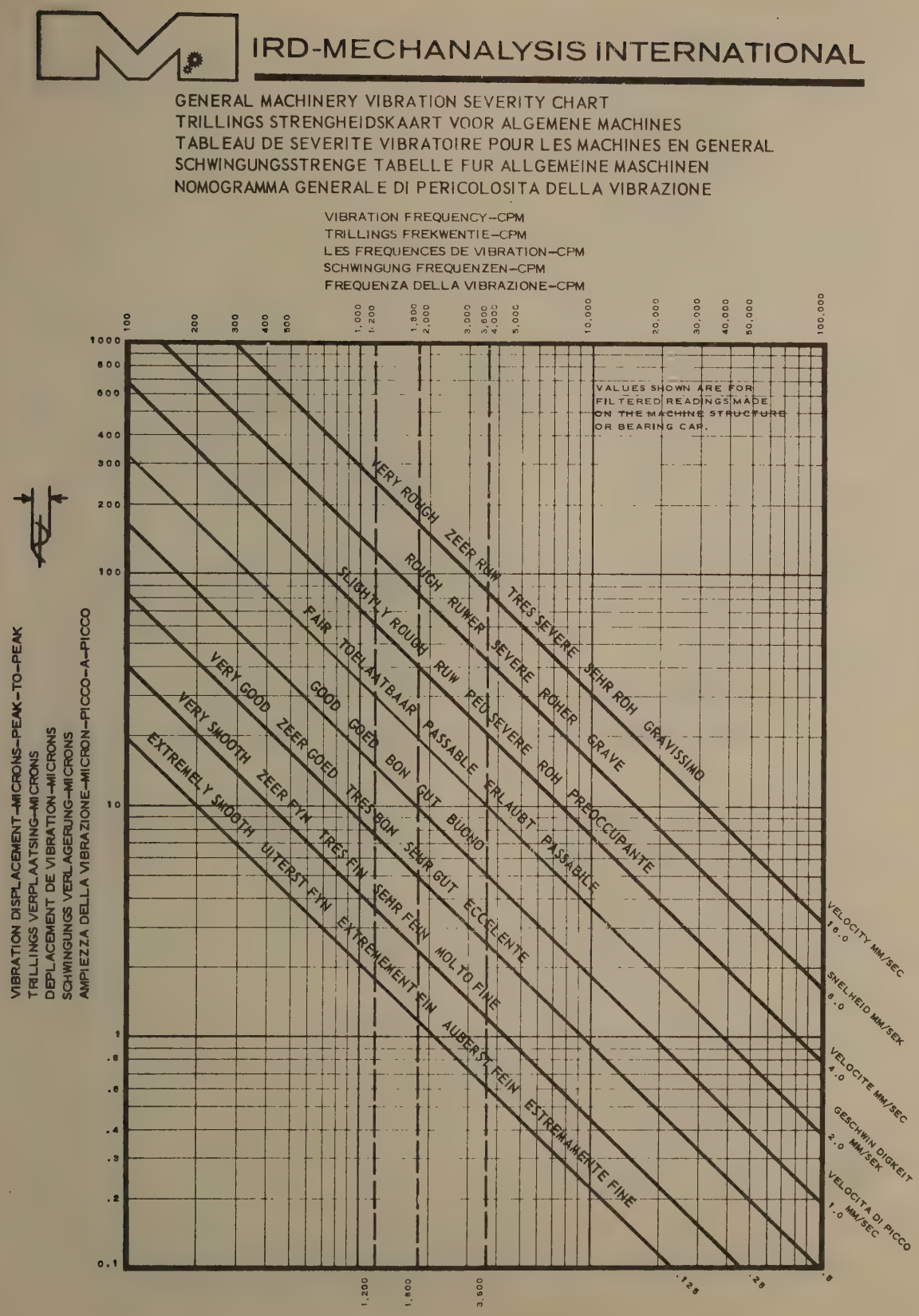

IRD-MECHANALYSIS INTERNATIONAL
GENERAL MACHINERY VIBRATION SEVERITY CHART
TRILLINGS STRENGHEIDSKAART VOOR ALGEMENE MACHINES
TABLEAU DE SEVERITE VIBRATOIRE POUR LES MACHINES EN GENERAL
SCHWINGUNGSSTRENGE TABELLE FUR ALLGEMEINE MASCHINEN
NOMOGRAMMA GENERALE DI PERICOLOSITA DELLA VIBRAZIONE
VIBRATION FREQUENCY–CPM
TRILLINGS FREKWENTIE–CPM
LES FREQUENCES DE VIBRATION–CPM
SCHWINGUNG FREQUENZEN–CPM
FREQUENZA DELLA VIBRAZIONE–CPM
VALUES SHOWN ARE FOR FILTERED READINGS MADE ON THE MACHINE STRUCTURE OR BEARING CAP.
VERY ROUGH ZEER RUW TRES SEVERE SEHR ROH GRAVISSIMO
ROUGH RUWER SEVERE ROHER GRAVE
SLIGHTLY ROUGH RUW PEU SEVERE ROH PREOCCUPANTE
FAIR TOELAATBAAR PASSABLE ERLAUBT PASSABILE
GOOD GOED BON GUT BUONO
VERY GOOD ZEER GOED TRES BON SEHR GUT ECCELENTE
VERY SMOOTH ZEER FYN TRES FIN SEHR FEIN MOLTO FINE
EXTREMELY SMOOTH UITERST FYN EXTREMEMENT FIN AUBERST FEIN ESTREMAMENTE FINE
VIBRATION DISPLACEMENT–MICRONS–PEAK–TO–PEAK
TRILLINGS VERPLAATSING–MICRONS
DEPLACEMENT DE VIBRATION–MICRONS
SCHWINGUNGS VERLAGERUNG–MICRONS
AMPIEZZA DELLA VIBRAZIONE–MICRON–PICCO–A–PICCO
VELOCITY MM/SEC
SNELHEID MM/SEK
VELOCITE MM/SEC
GESCHWIN DIGKEIT MM/SEK
VELOCITA DI PICCO MM/SEC

Figure 33 Vibration Severity Chart in Microns

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ADDENDUM
Model 360 Manual
Part No. 9768
Jan. 9,1979

On Page A-4, the vibration pickup input for velocity should be changed as follows:

1. The capacitor should not be used.

2. Pin A should connect to ground.

3. Pin B should connect the velocity input signal.

4. Pin C should not be used.

INDEX TO CONTENTS
...APPENDIX A...

		Page
A.1	Test Equipment Required	A-1
A.2	Preliminary Steps	A-1
A.3	Signal Conditioner Calibration	A-3
A.4	Alignment Procedure	A-5
A.5	Phase Meter Calibration	A-8
A.6	Frequency and Amplitude Recorder Output Calibration	A-9
A.7	Spectrum Analysis Sweep Generator Calibration	A-10
A.8	Scope Receptacle Output Test	A-11
A.9	Spectrum Analysis Amplitude Calibration	A-11
A.10	Test Adjustments	A-12
A.11	Log Amplifier Calibration	A-12

INDEX TO ILLUSTRATIONS

Figure	Description	Page
A-1	Physical Layout of Internal PC Boards and Controls.	A-2
A-2	Details on Test Capacitor Connection	A-4
A-3	Spectrum Analysis Generator PC Board	A-15
A-4	Digital Sweep PC Board	A-17
A-5	Signal Conditioner Charge Amplifier PC Board	A-19
A-6	Signal Conditioner Acceleration Amplifier PC Board	A-21
A-7	Signal Conditioner Low Pass Filter PC Board	A-23
A-8	Log Amplifier PC Board	A-25
A-9	Signal Conditioner Velocity Intergrator PC Board	A-27
A-10	Input Multiplier and Low Pass Filter, A-B PC Board	A-29
A-11	DC Amplifier and Output Multiplier PC Board	A-31
A-12	Output Amplifier Active Rectifier, 1KC Sin/Cosine Oscillator PC Board	A-33
A-13	Phase Meter Circuit PC Board	A-35
A-14	±15 Volt Power Supply PC Board	A-37
A-15	$\overline{2}$5 Volt Unregulated and 5 Volt Power Supply PC Board.	A-39
A-16	Digital Sweep PC Board	A-41
A-17	Digital Sweep Frequency Limit PC Board	A-43
A-18	No. 1 Sawtooth MV-FF PC Board	A-45
A-19	Reference Input PC Board	A-47
A-20	Signal Preamplifier PC Board	A-49
A-21	No. 2 Sawtooth MF-FF PC Board	A-51
A-22	Error Gate Pulse Doubler Divide,2 JK-FF PC Board	A-53
A-23	Frequency to DC Converter PC Board	A-55
A-24	DC Amp. and Rec. Output, Amp. Meter Circuit PC Board.	A-57
A-25	Electronic Switch and Integrator PC Board	A-59
A-26	Main PC Board	A-61
A-27	Front Panel Assembly	A-63
A-28	Phase Control Lights and Recorder DC Output PC Board.	A-65
A-29	Digital Sweep Temperature Module	A-67
A-30	Block Diagram of System Test and Phase Circuits	A-69
A-31	Block Diagram of Track Balance Filter Out Modes and Signal Conditioner and Signal Preamplifier Circuits	A-71
A-32	Block Diagram of Pulse to Sin/Cosine Circuits	A-73

INDEX TO CONTENTS CONTINUED
...APPENDIX A...

Figure	Description	Page
A-33	Block Diagram of Synchronous Filter and Frequency to DC Converter Circuits	A-75
A-34	Diagram of Interconnection and Switching Circuits . .	A-77
A-35	Schematic Diagram of Signal Conditioner Circuits . .	A-79
A-36	Schematic Diagram of Reference Input Conditioning and 1'st Square Wave Generator Circuits	A-81
A-37	Schematic Diagram of Reference Frequency Doubler and 2'nd Square Wave Generator Circuits	A-83
A-38	Schematic Diagram of Sin/Cosine Reference Circuits .	A-85
A-39	Schematic Diagram of Signal Preamplifier Synchronous Filter Output and Log Amplifier Circuits	A-87
A-40	Schematic Diagram of Synchronous Filter Circuits . .	A-89
A-41	Schematic Diagram of Phase Circuits	A-91
A-42	Schematic Diagram of Digital Controlled Sweep Generator Circuits	A-93
A-43	Schematic Diagram of Power Supply Circuits	A-95

APPENDIX A
... MODEL 360 CALIBRATION INSTRUCTIONS ...

A.1 TEST EQUIPMENT REQUIRED

1. One AC-DC millivolt meter with center zero (0) DC Scale, Dynamics Type 501, or equivalent.

2. One 1000 Pfd. capacitor in shielded case, film type, 1% tolerance, or better.

3. One oscilloscope with adjustable sweep rate, ± trigger control, and dc coupling.

4 One variable phase signal generator, with capacity of 2 volts ac rms square wave reference output, and 764 mv ac rms variable phase sine wave signal output.

5. One set of instrument cables for 360, for vibration and reference input.

NOTE: The Model 360 must be removed from its case, to do this, take out the eight holding screws, and pull the instrument from the case. Normally, the instrument is fitted snugly into the case, therefore, some difficultly may be encountered in its removal.

The physical layout of the Model 360 interior is illustrated in Figure A-1. Refer to this illustration throughout the calibration.

A.2 PRELIMINARY STEPS

1. Set the mechanical adjustment of each meter for zero indication on these meters.

2. Remove all PC Boards except the 9616 and 9617 assemblies, then turn on the instrument supply voltage and adjust the following controls:

   a. Adjust R1692 so that -15VDC is measured from TEST POINT 1603 (violet).

   b. Adjust R1691 so that +15 VDC is measured from TEST POINT 1601 (red).

3. Turn off the 360 supply voltage, then reinsert each PC Board.

4. Turn on the 360 supply voltage and warm up instrument for five minutes. Then check AMPLITUDE METER for zero (0) indication in all modes except TEST. If required, adjust potentiometer R1396 (see Figure A-1) to obtain zero indication on the meter.

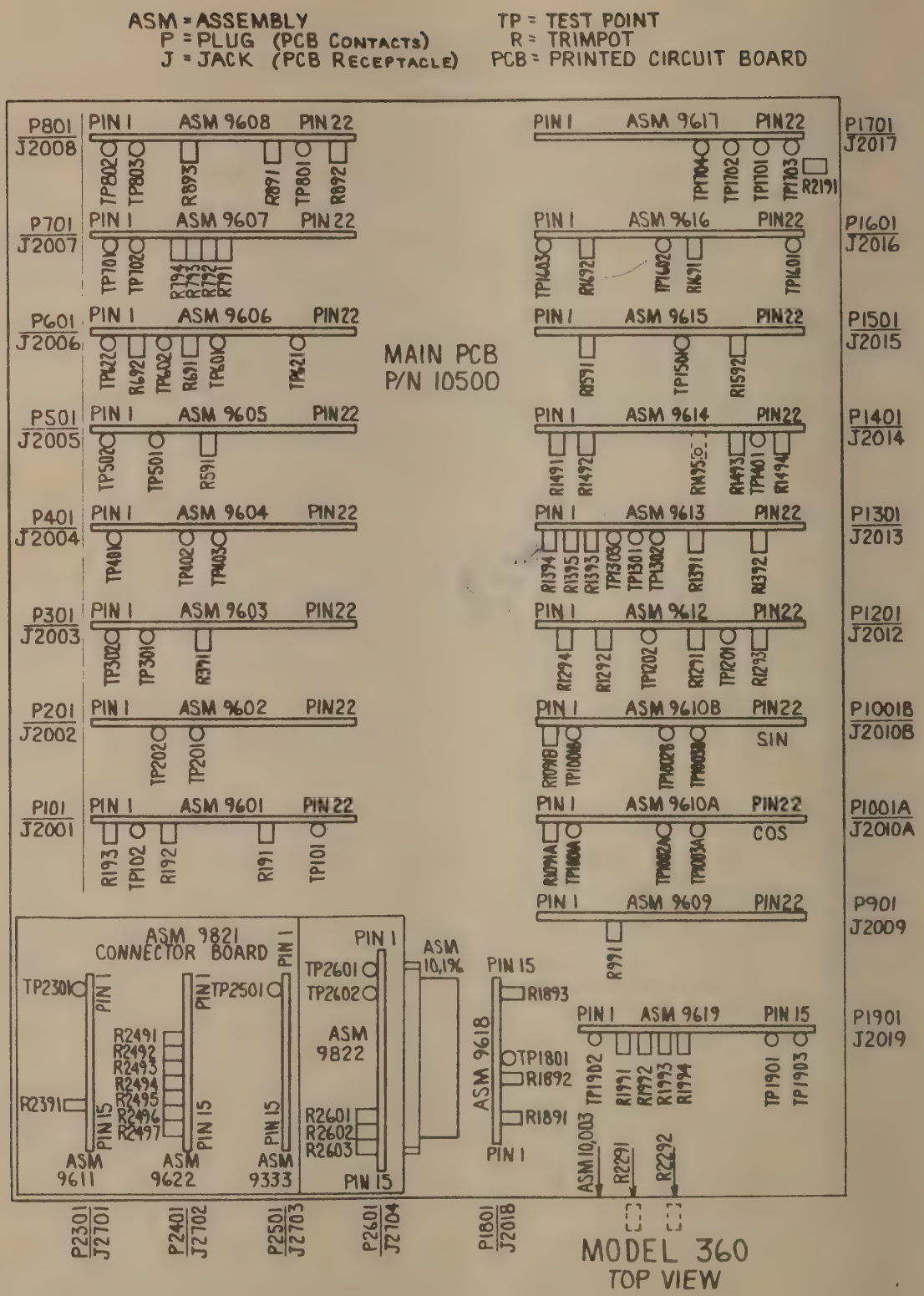


Figure A-1 Physical Layout of Internal PC Boards and Controls

DO NOT USE 1000pf capacitor 360
for velocity pickup

A.3 SIGNAL CONDITIONER CALIBRATION

The Signal Conditioner is located inside the gold colored box at the left-front of the instrument. The internal PC Boards are accessible when the cover is removed. To remove, take out the two screws at each side of cover, and lift cover off. See Figure A-5, A-6, A-7, and A-9 for PC Board layouts.

1. Setup for 360 controls as follows:

   a. Set FUNCTION CONTROL to FILTER OUT/FREQUENCY.
   b. Set PICKUP SELECTOR To VEL-PU-IN/SEC (MM/SEC in metric units).
   c. Set AMPLITUDE RANGE SELECTOR to 0.3 (10 in metric units).
   d. Set VELOCITY SENSITIVITY CONTROL to 764.

2. Connect the active side of Variable Phase Generator sine wave output line to Pin B of input signal connector (the Model 544 Pickup cable can be used for this signal connection, Pin B is used for active side, and Pin A is used for the GROUND side). Connect the GROUND side of the generator output to Pins A [redacted] of input connector.

NOTE: Do not connect the reference cable until so instructed.

3. Set up the signal generator output to 100 Hz (frequency) and 240 mv, ac, rms output (set to 301 mv for metric unit).

4. Adjust R2691 (R2601) (see Figure A-6) for 22.9 mv ac output at TEST POINT 2601 (brown), ground reference point is TP2602).

5. Adjust R191 (Fig. A-1) for output for 700 mv, ac, rms at TEST POINT 101 (Gray).

6. Adjust R192 (Fig. A-1) so that a full-scale indication is obtained on the top scale ofthe AMPLITUDE METER.

7. Setup the 360 controls as follows:

   a. Set AMPLITUDE RANGE CONTROL to 1 (30 in metric units).
   b. Set PICKUP SELECTOR to VEL-MILS (VEL-MICRONS in metric units).

8. Set up signal generator for output level of 240 mv, ac, rms, and frequency of 100 Hz (in metric units, set output to 284 mv).

9. Adjust R2692 (R2602) (Fig. A-6) for output of 700 mv, ac, rms, at TEST POINT 101 (Gray).

10. Disconnect vibration input, set ACCELEROMETER SENSITIVITY CONTROL to 000, and set PICKUP SELECTOR CONTROL to "g".

Clockwise

11. Adjust R2391 (Fig. A-1) so that a minimum dc output of less than 10 mv is obtained at TEST POINT 2301 (Red).

12. Connect the 1000 Pfd test capacitor (see A.1 Step 2) in series with Pin C of the input connector. (The capacitor must be enclosed in a grounded metal box or shield, and a film type capacitor with minimum tolerance of 1% must be used).

NOTE: In Step 12, the capacitor must be located within six inches of the 360, and the capacitor must be connected through a shielded cable or low-noise cable (such as an accelerometer input cable (see Figure A-2). Pins A and B of the input connector should be grounded. If an accelerometer cable is used, Pin A will be grounded, and Pin B will be in series with the 1000 Pfd test capacitor, at the pickup end.

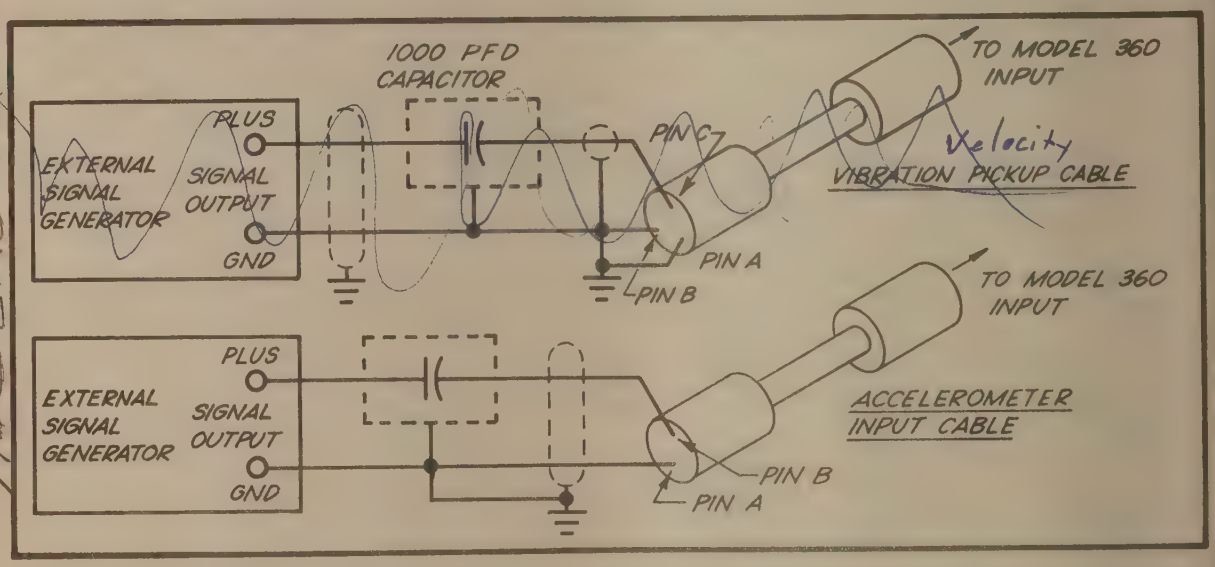


Figure A-2 Details on Test Capacitor Connection

13. Connect an ac voltmeter to TEST POINT 2301 (Red) and check that signal generator is set to 100 Hz. Then set up the signal generator to each value listed in the following table, also measure the output at TEST POINT 2601 (Figure A-3) (Brown) for each input and potentiometer adjustment listed in the table:

AMP RANGE SETTING	INPUT AT TP2301	OUTPUT AT TP2601	ADJ POT
0.01	0.354 MV	22.9 MV	R2497
0.03	1.12 MV	22.9 MV	R2496
0.1	3.54 MV	22.9 MV	R2495
0.3	11.2 MV	22.9 MV	R2494
1.0	35.4 MV	22.9 MV	R2493
3.0	112.0 MV	22.9 MV	R2492
10.0	353.5 MV	22.9 MV	R2491

14. Set the AMPLITUDE RANGE CONTROL to 1 (30 in metric units), and set the PICKUP SELECTOR to ACCELEROMETER IN/SEC (MM/SEC in metric units).

15. Set up the signal generator for 35.4 mv, ac at 61.4 Hz (49.3 Hz in metric units) output at TP2301 (Red), Fig. A-1.

16. Adjust R2693 (Fig. A-3) for an output of 700 mv, ac, at TEST POINT 101 (Gray) (Fig. A-1).

A.4 ALIGNMENT PROCEDURE

1. Set up the 360 controls as follows:

   a. Set the FUNCTION CONTROL to BALANCE.
   b. Set the PICKUP SELECTOR to VEL PU-IN/SEC (MM/SEC in metric units).
   c. Set the VELOCITY SENSITIVITY CONTROL to 764.
   d. Set the FREQUENCY RANGE SELECTOR TO 600-6K range.
   e. Set the RECORDER switch to OPERATE.
   f. Set the REFERENCE ADJUST to 5.

2. Connect an Electromagnetic Pickup input cable to connect a reference output square wave to the 360. (Use Pin B for active side, and Pin C for ground).

3. Connect a 2-volt rms input at 100 Hz (frequency) to the 360.

4. Connect a dc coupled oscilloscope to TEST POINT 702 (yellow), Figure A-1. Set the trigger slope to plus, then setup R792 for a 70 percent positive duty cycle.

5. Set up R895 for an indication of 600 on the FREQUENCY METER.

6. Set up the 360 RANGE SELECTOR to each value listed in the following table, and adjust the corresponding potentiometer so that the FREQUENCY METER indication listed for each range is obtained:

FREQ. RANGE SEL. POS.	~~FREQ. METER INDICATION~~ SIGNAL COND FREQ	ADJUST POTENTIOMETER
120 to 600	10 Hz	R791
6K to 60K	1K Hz	R793
60K to 600K	10K Hz	R794

7. With the signal generator set at 100 Hz, and the RANGE SELECTOR at the 600-6K range, adjust R891 so that +10 VDC output is obtained at TEST POINT 801 (Red).

8. Check voltage at TEST POINT 802 (Green), this voltage should be between -9.8 and -10.2 volts dc.

9. With an input of 10Hz, check for output of +1 volt at TEST POINT 801 and -1 volt at TEST POINT 802.

10. With the signal generator set at 100 Hz, adjust 2893 so that +6 volts dc are obtained at the FREQUENCY BNC receptacle at right-hand side of 360.

11. Set up the REFERENCE ADJUST control on front panel of 360 so that voltage at Pin 7 of 9602 PC Board is below ± 10 mv, dc. Then loosen the REFERENCE ADJUST dial and set to 5.

12. Set the REFERENCE ADJUST dial to 4.5, then lock dial.

13. Set the signal input to 50HZ, and the input signal level to 2 volts (square-wave reference).

14. Set up R391 for a 50 percent duty cycle, at TEST POINT 302 (Red). The 50 percent duty cycle is obtained when the plus (+) and minus (-) excursion times are equal. Use the dc coupled oscilloscope for measurement during this adjustment.

15. Set up R591 for a 50 percent duty cycle at TEST POINT 502 (Red).

16. Adjust R692 so that a 16 volt peak-to-peak triangular wave output is obtained at TEST POINT 622 (yellow). Measure this output with the dc coupled oscilloscope.

17. Connect the dc oscilloscope input to TEST POINT 602 (Gray), and adjust R691 so that a 16 volt peak-to-peak triangular wave output is obtained.

18. Adjust R1091A for a 7-volt rms ac output at TEST POINT 1001A (White).

19. Adjust R1091B for a 7 volt rms ac output at TEST POINT 1001B (White).

20. Adjust R1293 so that a minimum dc voltage is output at TEST POINT 1201 (Green), this voltage should be less than 10 mv, dc.

21. Adjust R1294 so that a minimum dc voltage is output at TP1202 (Red).

22. Disconnect the reference input cable from the 360, then adjust R1396 so that zero (0) is indicated on the AMPLITUDE METER.

23. Set up the 360 controls as follows:

    a. Set the AMPLITUDE RANGE control to 1 (10 for metric units).
    b. Set the PICKUP SELECTOR to VELOCITY PICKUP in IN/SEC (MM/SEC for metric units).
    c. Set the FREQUENCY RANGE SELECTOR to the 600 - 6K range.
    d. Set the FUNCTION SELECTOR to TRACK.
    e. Set the RECORDER CONTROL to OPERATE.
    f. Set the VELOCITY SENSITIVITY CONTROL to 764.
    g. Connect the Vibration and Reference inputs to the 360.

24. Set the signal generator FREQUENCY selector to 50Hz (100Hz can be used if power line frequency is 50Hz), and set the generator output to 2 volts, rms, square wave. Also set the vibration signal input to a 764 mv, rms (301 in metric units) level sine wave.

25. Readjust R191 (slightly) if required, so that an output of 700 mv, ac, rms is obtained at TEST POINT 101 (Gray).

NOTE: In Step 25, do not consider the AMPLITUDE METER indication.

26. Set up the dc meter to the 10 volt range, and connect to TEST POINT 1201 (Green).

27. Rotate the Phase Dial of the signal generator slowly, beginning at the zero (0°) degree position. A maximum positive and maximum negative indication will occur on the test meter, record the Phase Dial settings for each of these two voltage values.

    a. Positive (+) maximum _____ degrees.
    b. Negative (-) maximum _____ degrees.

28. With the Phase Dial set at the maximum positive (+) position determined in Step 27, adjust R1291 for an output of 10 VDC at TEST POINT 1201.

29. With the test meter connected to TEST POINT 1202 (Red), repeat Step 27 and record both Phase Dial settings.

    a. Positive (+) maximum _____ degrees.
    b. Negative (-) maximum _____ degrees.

30. With the Phase Dial set at the maximum negative (-) position determined in Step 29, adjust R1292 for an output of -10 VDC at TEST POINT 1202.

31. Turn the Phase Dial to the maximum positive (+) position determined in Step 29, then disconnect S1302 (see black wire and brass pin), Figure A-12.

32. Adjust R1391 so that 320 mv, ac, rms is obtained at red wire (brass pin) of S1301 (See Fig. A-12).

33. Reconnect black wire to S1302, and disconnect red wire from S1301 (see Fig. A-12).

34. Set the Phase Dial to the maximum negative (-) position determined in Step 27, then adjust R1392 a voltage of 320 mv, ac, rms at S1302.

NOTE: If 320 mv cannot be obtained in Step 34, the repeat Steps 32 and 34 for outputs of 380 mv. The same amplitude must be obtained in both of these steps.

35. Reconnect the red wire to S1301.

A.5 PHASE METER CALIBRATION

1. Set up the 360 controls as follows:

   a. Set the AMPLITUDE CONTROL to 1 (10 in metric units).
   b. Set the PICKUP SELECTOR to VELOCITY PU-IN/SEC (MM/SEC in metric units).
   c. Set the FREQUENCY RANGE SELECTOR TO 600-6K Range.
   d. Set the FUNCTION SELECTOR to TRACK.
   e. Set the RECORDER switch to OPERATE.
   f. Set the SENSITIVITY CONTROL to 764.
   g. Set the signal generator frequency to 50Hz, set the reference signal to 2 volts, ac, rms, square wave, and set the vibration signal voltage to 764 mv, ac, rms (301 mv for metric units) sine wave.

2. Set the signal generator Phase Dial to zero (0) degrees, then rotate 360 Phase Adjust control slowly until a minimum dc voltage is obtained at TEST POINT 1401 (White).

3. Adjust R1492 so that a minimum dc voltage is obtained at Pin 10 of IC1402 (this voltage value should be less than two (2) millivolts). Then adjust R1493 to obtain a minimum dc voltage at Pin 10 of IC1403 (this voltage should also be less than two (2) millivolts).

4. Disconnect the vibration signal from the 360, then adjust R1495 so that an indication of zero (0) is obtained on the PHASE METER.

5. Reconnect the vibration signal to the 360, then check that the voltage at TEST POINT 1401 (White) is less than 30 mv, dc, and that zero degrees (0°) is still indicated on the PHASE METER.

6. Set the Phase Dial of generator to 180°, then adjust R1494 so that 180° is indicated on the 360 PHASE METER. Then

retune the Phase Dial for peak setting, and readjust R1494 for a 180° phase indication.

7. Turn the Phase Dial to zero degree (0°) position and check that 360 PHASE METER indicates zero degrees (0°). Then adjust R1592 so that both Phase Lights of 360 are glowing.

8. Rotate the Phase Dial and check that the dc voltage at the PHASE OUTPUT receptacle (at right-hand side) increases to a peak value, and decreases to zero volts when the phase passes through 360°. When this voltage is at its peak value, adjust R1591 for an output of 3.6 volts, dc at this receptacle.

9. Check that a vibration signal of 764 mv is input to the 360, then adjust R1393 for a full-scale indication on the top scale of the AMPLITUDE METER.

10. When the RECORDER switch is set to FULL SCALE, and the FUNCTION SELECTOR set to SPECTRUM ANALYSIS, adjust R1394 for a full-scale indication on the AMPLITUDE METER. Then reposition the RECORDER switch to OPERATE.

11. With the FUNCTION SELECTOR set to FILTER OUT/SPEED, and the RANGE SELECTOR set to 0.1 (1.0 in metric units), adjust R193 so that the OVERLOAD LIGHT is flickering on and off, (make certain that the vibration signal level is 764 mv, ac, rms).

A.6 FREQUENCY AND AMPLITUDE RECORDER OUTPUT CALIBRATION

1. Set up the 360 controls as follows:

   a. Set the FUNCTION SELECTOR to FILTER OUT FREQUENCY.
   b. Set the PICKUP SELECTOR to VEL-IN/SEC (MM/SEC for metric units).
   c. Set the AMPLITUDE RANGE CONTROL to 1 (10 for metric units).
   d. Set the FREQUENCY RANGE SELECTOR to 600-6K range.
   e. Set the RECORDER SWITCH to OPERATE.
   f. Set the SENSITIVITY CONTROL to 764.
   g. Set the FREQUENCY of generator to 100 Hz.
   h. Set reference input voltage to 2 volts, ac, rms, square wave.
   i. Set the vibration input signal level to 764 mv, ac, rms, sine wave (301 mv for metric units).

2. Adjust R1395 for an output of 5 volts, dc at the AMPLITUDE LINEAR recorder receptacle of the 360.

A.7 SPECTRUM ANALYSIS SWEEP GENERATOR CALIBRATION

1. Set up the 360 controls as follows:

   a. Set the FUNCTION SELECTOR to SPECTRUM ANALYSIS.
   b. Set the AUTO-MANUAL selector to AUTOMATIC.
   c. Set the FREQUENCY RANGE SELECTOR to the 60K to 600K range.
   d. Turn the MINIMUM FREQUENCY CONTROL fully CCW.
   e. Turn the MAXIMUM FREQUENCY CONTROL fully cw.

NOTE: Connect only the supply voltage conductors to the 360.

2. Depress the START-RESET push button. The button will light and the PEN LIFT relay will become oversized. After a few seconds, the FREQUENCY METER indicator will move up-scale. At 600 the indicator will stop, and the PEN LIFT relay will become deenergized. When the sweep is stopped, adjust R981 for 600 on the FREQUENCY METER.

3. Set the FREQUENCY RANGE SELECTOR to the 6K - 60K range, and check the FREQUENCY METER indication. If the meter does not indicate 600 ±2 Hz, then capacitor C906 (of PC Board 900) should be padded such that the correct meter indication is obtained. Increasing the amount of capacitance will decrease the maximum frequency reading.

4. Pad the following capacitors in the same manner used in Step 3:

RANGE	CAPACITOR TO PAD
600-6K	C905 - 0.33 Mfd.
120-600	C904 - 3.0 Mfd.

5. Repeat Step 2, and recheck each range.

6. Set the FREQUENCY SELECTOR to the 600-6K range, and set the RECORDER SWITCH to ZERO CALIBRATE. Then adjust R2291 (see Fig. A-1) such that an indication of 600 is obtained on the FREQUENCY METER.

7. Set the RECORDER SWITCH to FULL SCALE CALIBRATE, and adjust R2292 (see Fig. A-1) such that an indication of 600 is obtained on the FREQUENCY METER.

8. Set the RECORDER SWITCH to OPERATE, and set the AUTO-MANUAL SWITCH to MANUAL, then adjust the MANUAL TUNING control from its fully CCW position to its fully CW position while watching the FREQUENCY METER. The FREQUENCY METER indicator must be moved from 600 on the meter scale to beyond the extreme high end of the calibrated scale.

A.8 SCOPE RECEPTACLE OUTPUT TEST

1. Set the 360 to FILTER OUT/FREQUENCY, and apply an input signal for full-scale indication on the AMPLITUDE METER. Then check that from 0.6 to 0.8 vac, rms is output at the SCOPE RECEPTACLE.

A.9 SPECTRUM ANALYSIS AMPLITUDE CALIBRATION

1. Set up the 360 controls as follows:

   a. Connect an X-Y Recorder to the 360, and set up the recorder.
   b. Set the FUNCTION SELECTOR to BALANCE.
   c. Set the PICKUP SELECTOR to VELOCITY PU-IN/SEC (MM/SEC for metric units).
   d. Set the AMPLITUDE RANGE control to 1 (10 for metric units).
   e. Set the FREQUENCY RANGE SELECTOR to the 120-600 range.
   f. Set the RECORDER SWITCH to OPERATE.
   g. Set the PICKUP SENSITIVITY CONTROL to 764.
   h. Set the AUTO-MANUAL CONTROL to AUTOMATIC.

2. Depress and release the START-RESET switch such that the light inside this switch is turned off.

3. Set the external signal generator FREQUENCY SELECTOR to 5 Hz, then increase the vibration input signal such that the AMPLITUDE METER indicates full scale (the input should be approximately 2 vac, rms).

4. Set the FUNCTION SELECTOR of 360 to SPECTRUM ANALYSIS.

5. Depress and release the START-RESET control to turn on the 360 analyzer. Obtain an amplitude plotting with the X-Y Recorder. When the plotting is completed, and the recorder pen is positioned at BASE LINE, again depress and release the START-RESET control.

6. Adjust the X ZERO CONTROL such that the zero point of the X-Y Recorder is moved 1/2 inch to left.

7. Repeat Steps 5 and 6 until ten distinct recorder plottings have been recorded.

NOTE: Before the 360 is switched to SPECTRUM ANALYSIS, the signal level must always be checked in the BALANCE mode.

8. Set up a SPECTRUM ANALYSIS for each input signal level, and FREQUENCY RANGE SETTING listed in the following table. Adjust the potentiometer listed for each range such that the tolerance value included in the table for each range is met (see Table at top of Page A-12):

SPECTRUM ANALYSIS SETUP TABLE

INPUT SIGNAL LEVEL	FREQUENCY RANGE SETTING	CALIBRATION POTENTIOMETER	TOLERANCE LIMIT
5 Hz	120 to 600	R1991	±5 PERCENT
50 Hz	600 to 6K	R1992	±5 PERCENT
500 Hz	6K to 60K	R1993	±5 PERCENT
5000 Hz	60K to 600K	R1994	±6 PERCENT

NOTE: Occasionally, the tolerance obtained by adjustment of R1994 may extend to ±10 percent.

A.10 TEST ADJUSTMENTS

1. Set up the 360 controls as follows:

   a. Set the FUNCTION CONTROL to TEST.
   b. Set the FREQUENCY RANGE SELECTOR to 600-6K range.

2. If 60 Hz supply line voltage is used, an indication of from 353° to 367° should be obtained on the FREQUENCY METER (an indication of from 293° to 307° should be obtained if a 50 Hz supply line voltage is used).

3. Set up potentiometer R2191 (Fig. A-1) so that an indication of 0.84 is obtained on the 0 to 1 scale of the AMPLITUDE METER.

A.11 LOG AMPLIFIER CALIBRATION

1. Set up the 360 controls as follows:

   a. Set the FUNCTION SELECTOR to TRACK.
   b. Set the PICKUP SELECTOR to VEL PU-IN/SEC (MM/SEC for metric units).
   c. Set the SENSITIVITY CONTROL to 764.
   d. Set the REFERENCE ADJUST to 4.5.
   e. Set the FREQUENCY RANGE SELECTOR to 600-6K range.
   f. Set the AMPLITUDE RANGE SELECTOR to 1 (to 10 for metric units).
   g. Set the RECORDER SWITCH to ZERO.

2. Connect the dc test voltmeter to the AMP LOG BNC receptacle (at right-hand side panel of 360) and ground, and connect only the ac supply voltage cord to the 360.

3. Adjust R1891 (Fig. A-1) so that a voltage close to zero (±20 mv, or less) is indicated on the test meter.

4. Set the RECORDER SWITCH to OPERATE, and connect the reference and vibration signal voltages to the analyzer. Set the reference voltage level to 2 volts (square wave at 100 Hz). Set up the vibration input for a full-scale

indication or the AMPLITUDE METER.

5. Adjust R1892 so that an indication of 5 VDC is obtained on the dc test meter.

6. Set the 360 AMPLITUDE SELECTOR to 30 (300 in metric units), and adjust R1893 so that the dc test meter indicates 2 VDC.

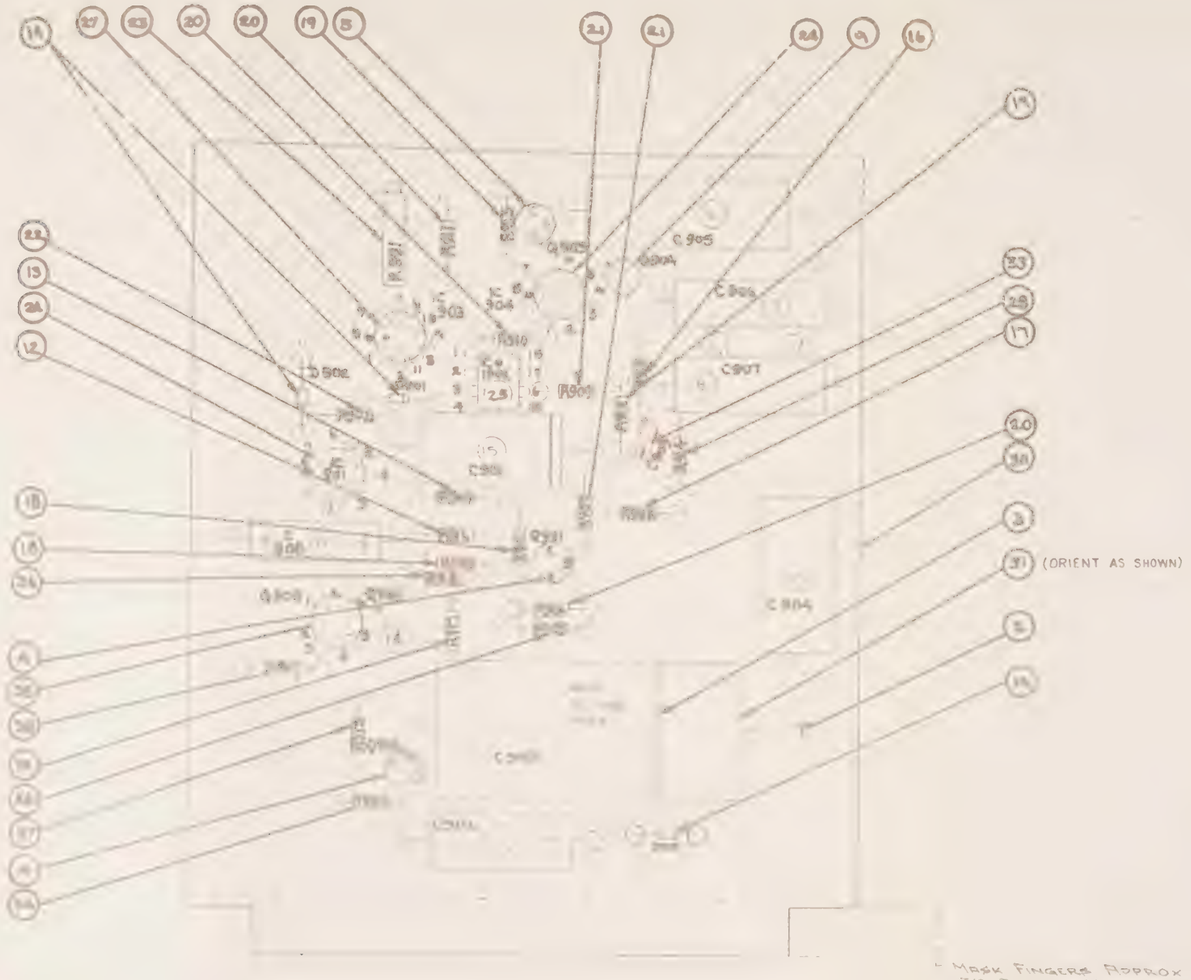
NOTE: Potentiometers R1892 and R1893 may interact with one another, therefore, Steps 5 and 6 should be repeated until the required test meter indications are obtained.

7. When the correct meter indications have been obtained in Steps 5 and 6, check the indications of the test meter for each AMPLITUDE RANGE setting listed in the following table.

AMPLITUDE RANGE CONTROL SETTING		DC TEST METER INDICATION REQUIRED
ENGLISH	METRIC	
1	10	5 ± 0.05 VOLT
3	30	4 ± 0.05 VOLT
10	100	3 ± 0.1 VOLT
30	300	2 ± 0.2 VOLT
100	1000	1 ± 0.5 VOLT

NOTE: This completes the Model 360 Analyzer calibration.

	REVISION	CHANGE NUMBER	CKD DATE	
A	REV D904 TO SHOW IN PROPER LOC. REV POLARITY OF D903. LOC TABS ADDED TO IC901 IC903 & IC904. MISC COPPER PATHS & PADS REV.	2215	11-77	CH 11-12
B	ADDED FIND NO'S 41 & 42	2435	9-28-77	10-26-77



41	00469	-		GC1 2-43 SPECTRUM ANALYSIS GEN. PCB ASM.
40	00969	-	D6-6233	SCHEMATIC
39	2365	9R		SOLDER, 60/40
38	5399	1		SEMICOND, IN5231B
37	9710	1		RESISTOR, 43.2K 1/8 W 1%
36	9274	1		RESISTOR, 20K 1/8 W 1%
35	5072	4		SEMICOND, 2N3806
34	7861	1		RESISTOR, 1B 2K 1/8 W 1%
33	5396	1		CAPACITOR, 6.8 MFD 20V
32	7860	1		RESISTOR 15K 1/8 W 1%
31	[illegible]	1		CAPACITOR, 25 MF 100V 10%
30	[illegible]	1	- - -	BOARD, SPECTRUM ANALYSIS GEN. P.C.
29	[illegible]	1		CAPACITOR 3 MF 50 5%
28	[illegible]	1		[illegible] 78 OHM, 1/8 W 1%
27	[illegible]	1		[illegible] 2.5 - 35 MF - 5%
26	[illegible]	1		RESISTOR, 32.4K 1/8 W 1%
25	[illegible]	1		[illegible] 34.8K - 1/8 W 1%
24	[illegible]	2		[illegible] MPC 1654
23	[illegible]	1		[illegible] 50V
22	[illegible]	1		RESISTOR, 475K 1/8 W 1%
21	[illegible]	2		RESISTOR 2.21K 1/8 W 1%
20	[illegible]	1		RESISTOR, 10K 1/8 W 1%
19	[illegible]	1		[illegible] 1/8 W 1%
18	[illegible]	1		[illegible] 1/8 W 1%
17	[illegible]	1		RESISTOR 475 OHM 1/8 W 1%
16	[illegible]	1		[illegible] 31.6 [illegible] 1/8 W 1%
15	[illegible]	1		CAPACITOR, 2 MF 50 V 10%
14	[illegible]	1		SEMICOND, IN914
13	[illegible]	1		RESISTOR, 100K 1/4 W 5%
12	[illegible]	1		[illegible] 1M 1/4 W 5%
11	[illegible]	1		[illegible] 5.6 MF
10	[illegible]	1		[illegible] 100 MF 25 V
9	[illegible]	1		[illegible] 2N2647
8	[illegible]	1		CAPACITOR, .0033 MF 100V 1%
7	[illegible]	1		CAPACITOR, .033 MF 100V 1%
6	[illegible]	1		CAPACITOR, 33 MF 50 V 1%
5	[illegible]	1		SEMICOND, 2N3638
4	[illegible]	1		SEMICOND, 2N3568
3	[illegible]	1		[illegible]
2	[illegible]	1		[illegible]
1	[illegible]	1		BOARD SPECT ANAL GEN PC ASM

	DESCRIPTION / SPECIFICATION	MODEL	NEXT ASSEMBLY	NO. REQ.
360	D2-1851	T1		

FRACTIONS ± 1/64 DECIMALS ± .005 ANGLES ± 1/2

DRAWN BY	CHECKED BY	APPROVED BY	APPROVED BY	SCALE REF ONLY
6-10-1973	[illegible]	19	9-1-77	2/1

TITLE: BOARD- SPECTRUM ANALYSIS GEN. P.C. ASM.

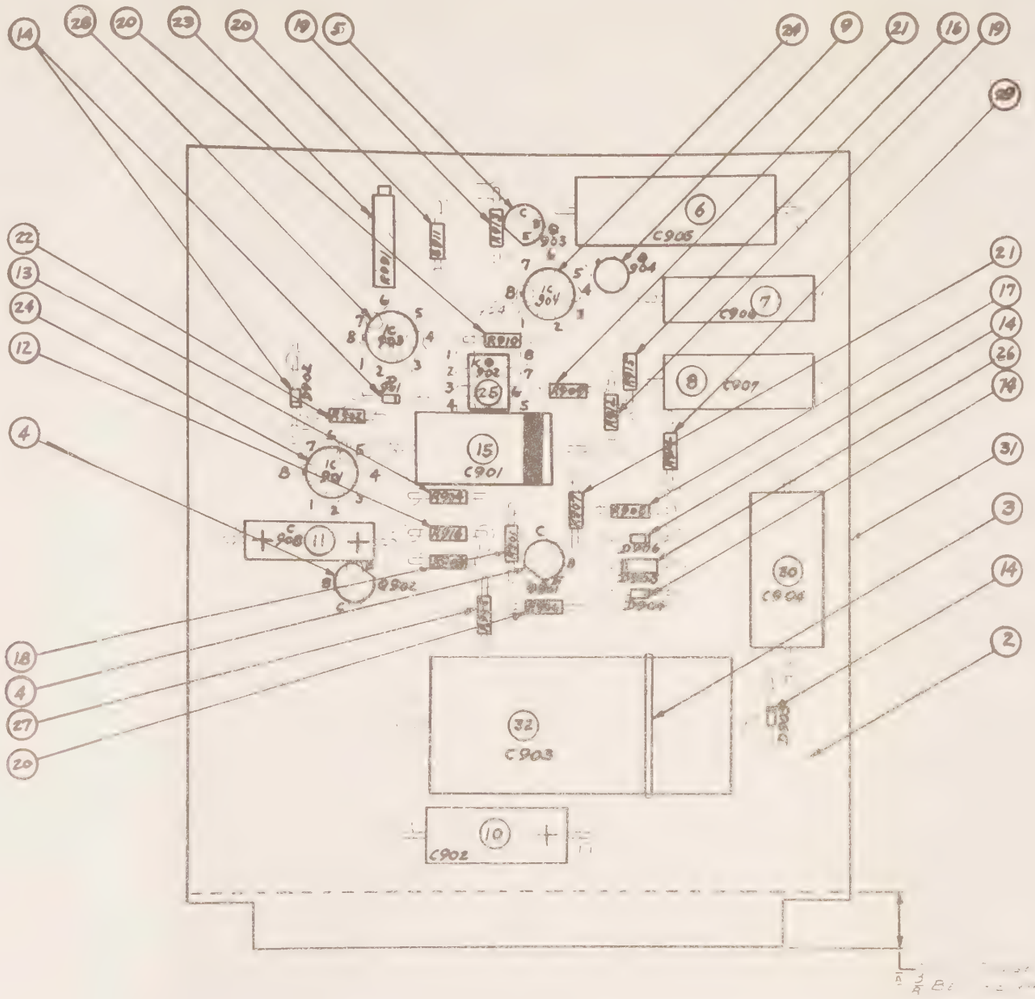
IRD MECHANALYSIS, INC.
COLUMBUS, OHIO

DRAWING NUMBER D2-7161 E SHEET

THIS DWG TO BE USED FOR "DASH FINISH H" ONLY

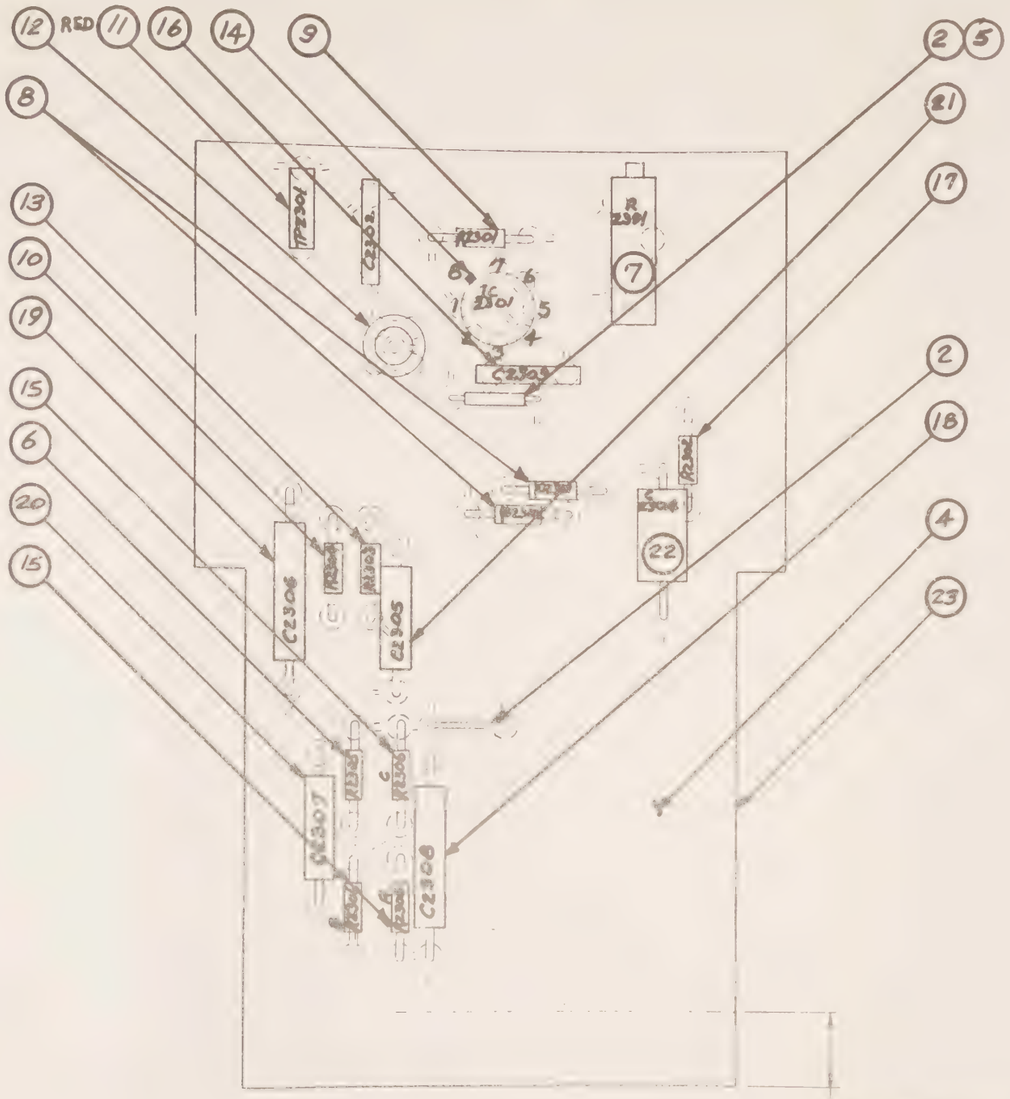
Generator Board

LTR	REVISION	CHANGE ORDER	CK'D DATE	APP'D DATE
A	ADDED MTG DETAIL & NOTE 3	~	NWL 3-5-74	
B	ADDED COMPONENT DESIG. NO. & NOTE #2	—	LATOURETTE 5-28-74	



SCOTT GRAPHICS 5-72 9048

LTR.	REVISION	CHANGE ORDER	CK'D DATE	APP'D DATE
A	ITEM 14 P.A.S.P/N 9301	~	WITHDRAWN 2-20-73	
B	ADDED MFG DETAIL & NOTES DELETED SPAGHETTI FROM ONE JUMPER	~	MWL 3-5-74	
C	ADDED COMPONENT LESIS, NO. & NOTE #2.	—	LATHROP 5-28-74	
D	ADDED FIND NOS. 24 + 25	2435	[illegible] 5-16-77	



CUT OFF LEAD LOCATED UNDER TAB

BOTTOM VIEW SCHEMATIC ITEM 14

ITEM NO	PART NO.	NO. REQ	DRAWING NO.	DESCRIPTION / SPECIFICATION	MODEL	NEXT ASSEMBLY	NO. REQ.
25	90513			QC1 2-87			
24	90969	—	D6-6233	SCHEMATIC			
23	10014	1	B4-5611	BOARD, SIG. COND. CHARGE AMP P.C.			
22	9896	1		CAPACITOR, .2MF 50V 1%			
21	9891	1		CAPACITOR, .0633 MF 50V 1%			
20	9890	1		CAPACITOR, .02MF 50V 1%			
19	9884	1		CAPACITOR, .00633 MF 50V 1%			
18	9881	1		CAPACITOR, .002 MF 50V 1%			
17	9868	1		RESISTOR, 665K 1/8W 1%			
16	9310	2		CAPACITOR, .1 MF 16V CERAMIC			
15	9305	3		RESISTOR, 22M 1/4W 5%			
14	10362	1		SEMICOND, BB-3622			
13	9267	1		RESISTOR, 1M 1/8W 1%			
12	B604	1		CONNECTOR, P.C. MOUNT AMP 331889			
11	7886	1		JACK, RED TEST			
10	7877	1		RESISTOR, 10M 1/4W 5%			
9	7842	1		RESISTOR, 68.1 OHM 1/8 W 1%			
8	5584	2		SEMICOND, IN5227			
7	5579	1		POT, 10K			
6	5289	1		RESISTOR, 6.8M 1/4W 5%			
5	3398	AR		SPAGHETTI, #24 GA.			
4	2878	AR		VARNISH			
3	2365	AR		SOLDER, 60/40			
2	2863	AR		WIRE, #22 GA BARE TINNED COPPER			
1	9611	1		BOARD, SIGNAL COND. P.C. ASM.	360	D2-5841	1

TOLERANCES UNLESS SPECIFIED OTHERWISE: FRACTIONS ± 1/64" DECIMALS ± 0.005" ANGLES ± 1/2°

DRAWN BY [illegible] CHECKED BY [illegible] APPROVED BY [illegible] APPROVED BY [illegible] SCALE REF ONLY

DATE 9-25-1973

TITLE: BOARD-SIGNAL CONDITIONER CHARGE AMP P.C. ASM. SC1

IRD MECHANALYSIS, INC. COLUMBUS, OHIO

DRAWING NUMBER C2-5698D SHEET 1 OF 1

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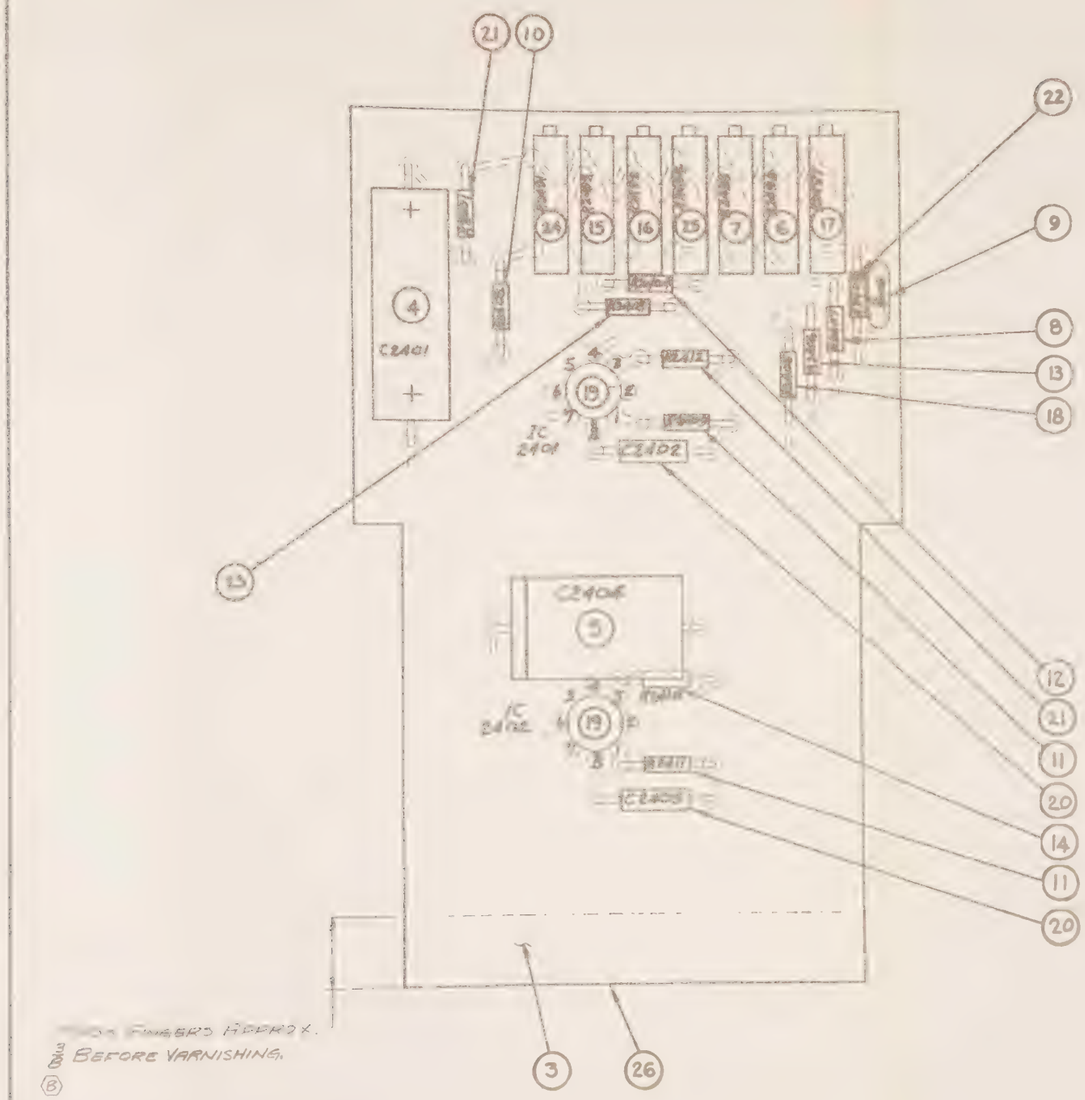
(D) 2. FOR SCHEMATIC SEE DWG. D6-6233

(B) 1. APPLY VARNISH, ITEM #4, TO BOTH SIDES OF BOARD AFTER ELECTRICAL CHECK.

NOTE:

Figure A-5 Signal Conditioner Charge Amplifier PC Board

LTR	REVISION	CHANGE ORDER	DR'D DATE	APPD DATE
A	WAS BOTTOM VIEW ITEM 19.	—	12-16-73	12-17-73
B	ADDED MTG. DETAIL & NOTES. BOTTOM VIEW INVERTED. I.E. "ITEM" 19	—	3-6-74	3-7-74
C	ADDED COMPONENT DETAIL N.O. & NOTE #2	—	8-29-74	8-29-74
D	ITEM 20 WAS 100V 10%	1756	7-28-75	7-31-75
E	ADDED FIND NO.'S 27 & 28	2635	5-14-77	5-16-77



(B) BEFORE VARNISHING.

(C) 2. FOR SCHEMATIC SEE DWG. D6-6233
1. APPLY VARNISH, ITEM #3, TO BOTH SIDES OF BOARD AFTER ELECTRICAL CHECK.

NOTE:

ITEM NO	PART NO	REV	DRAWING NO	DESCRIPTION / SPECIFICATION	MODEL	NEXT ASSEMBLY	INDL REQ.
(E) 28	9513	—		401-2-87			
(E) 27	10035	—	D6-6233	SCHEMATIC			
26	10025	1	C4-3687	BOARD, P.C.			
25	9938	1		POT, 2K			
24	9937	1		POT, 100 OHM			
23	9903	1		RESISTOR, 649 OHM ⅛W 1%			
22	9867	1		RESISTOR, 215K ⅛W 1%			
21	9861	2		RESISTOR, 4.02K ⅛W 1%			
20	9308	2		CAPACITOR, .0022MF-80V 5%			
19	9302	2		SEMICOND., BB-3057A/01			
18	9281	1		RESISTOR, 7.87K ⅛W 1%			
17	8339	1		POT, 100K			
16	8336	1		POT, 1K			
15	7884	1		POT, 500 OHM			
14	7871	1		RESISTOR, 475K ⅛W 1%			
13	7862	1		RESISTOR, 21.5K ⅛W 1%			
12	7851	1		RESISTOR, 2.15K ⅛W 1%			
11	7845	2		RESISTOR, 475 OHM ⅛W 1%			
10	7844	1		RESISTOR, 2.15 OHM ⅛W 1%			
9	7837	1		CAPACITOR, 100 PF			
8	7687	1		RESISTOR, 78.7K ⅛W 1%			
7	5579	1		POT, 10K			
6	5476	1		POT, 20K			
5	5044	1		CAPACITOR, 1MF-200V 10%			
4	5030	1		CAPACITOR, 50MF-25V NP			
3	2878	AR		VARNISH			
2	2365	AR		SOLDER 60/40			
1	9622			BOARD, SIG. CONDITIONER ACCEL AMP	360	D2-5841	1

UNLESS OTHERWISE SPECIFIED: FRACTIONS: ± 1/64" DECIMALS: ± 0.005" ANGLES: ± 1/2°

DRAWN BY	CHECKED BY	APPROVED BY	APPROVED BY	SCALE
R. Pearl	KATHROP	[illegible]	C. Spake	REF. ONLY

TITLE: BOARD, SIGNAL CONDITIONER ACCEL AMP. PC ASM. SC2

IRD MECHANALYSIS, INC. COLUMBUS, OHIO — DRAWING NUMBER C2-5104 E

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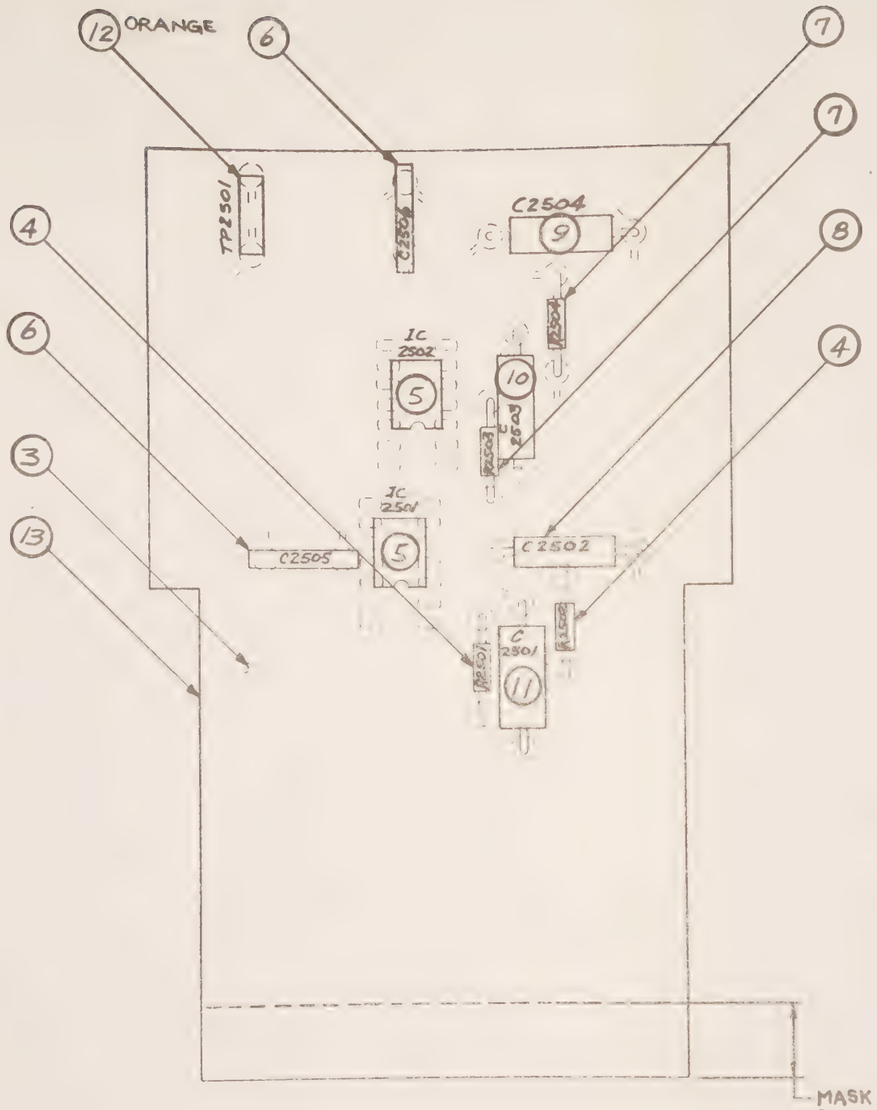
Figure A-6 Signal Conditioner Acceleration Amplifier PC Board

LTR	REVISION	ENG. ORDER	DATE	APPD
A	ADD VARNISH	~	NOV 1973 3-6-74	
B	ADDED COMPONENT DESIG. NO. & NOTE #2 (2)	—	4-5-74 5-28-74	
C	B/M UPDATE ONLY. NO DWG CHG.	2699	5-28-74 8-3-77	



ITEM NO	PART NO.	NO. REQ.	DRAWING NO.	DESCRIPTION / SPECIFICATION	MODEL	NEXT ASSEMBLY	NO. REQ.
13	10195	1	B4-5615	BOARD, SIG. COND. LOW PASS FILTER P.C.			
12	9941	1		JACK, ORANGE TEST			
11	9897	1		CAPACITOR, .3 MF 50V 1%			
10	9894	1		CAPACITOR, .15 MF 50V 1%			
9	9892	1		CAPACITOR, .1 MF 50V 1%			
8	9888	1		CAPACITOR, .015 MF 50V 1%			
7	9862	2		RESISTOR, 5.49K 1/8W 1% MF			
6	9310	2		CAPACITOR, .1 MF 16V CERAMIC			
5	8555	2		SEMICOND, 741 MINI-DIP			
4	7857	2		RESISTOR, 6.81K 1/8 W 1%			
3	2878	AR		VARNISH			
2	2365	AR		SOLDER, 60/40			
1	9330			BOARD, SIG. COND. L.P. P.C. ASM.	360	D2-5841	1

TOLERANCES UNLESS SPECIFIED OTHERWISE
FRACTIONS: ± 1/64" DECIMALS: ± 0.005" ANGLES: ± 1/2°

DRAWN BY	CHECKED BY	APPROVED BY	APPROVED BY	SCALE
8-1 1973	9-25 1973	9-17 1974	9-11 1974	REF. ONLY

TITLE: BOARD-SIGNAL CONDITIONER LOW PASS FILTER P.C. ASM, SC3

IRD MECHANALYSIS, INC.
COLUMBUS, OHIO

DRAWING NUMBER C2-5699 C | SHEET 1 OF 1

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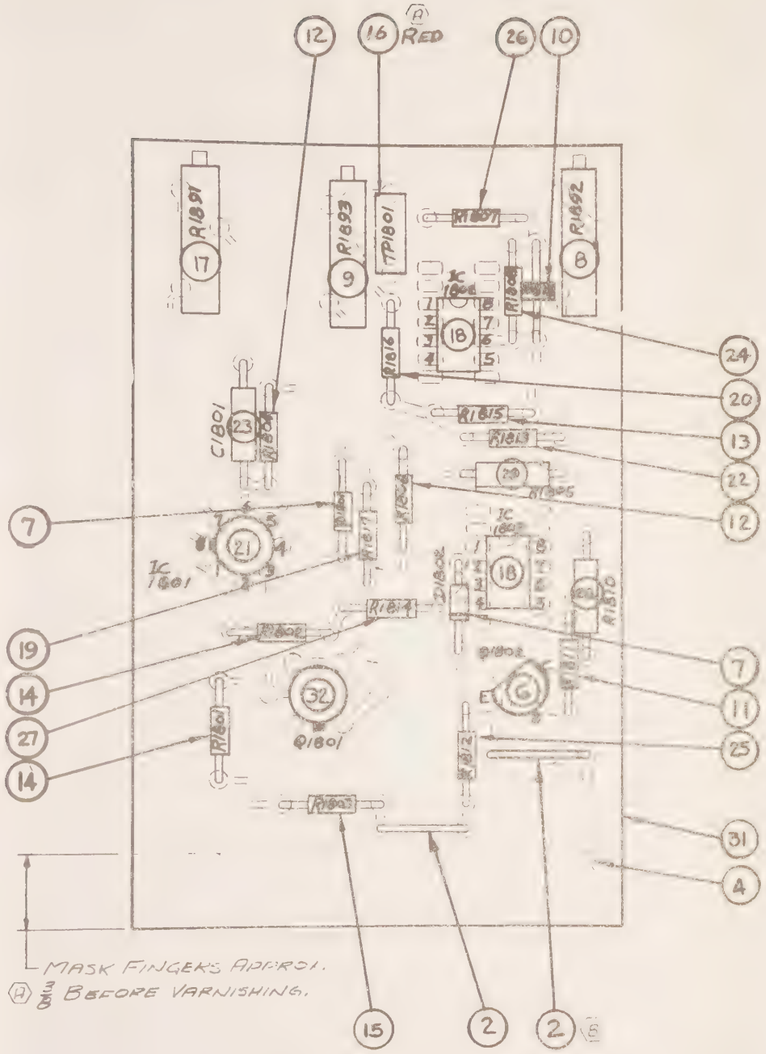
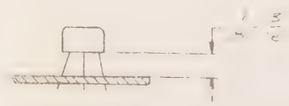
(B) 2. FOR SCHEMATIC SEE DWG. D6-6233.
1. APPLY VARNISH, ITEM #3, TO BOTH SIDES OF BOARD AFTER ELECTRICAL CHECK.
NOTE:

Figure A-7 Signal Conditioner Low Pass Filter PC Board

B	DELETED ITEM 30 & REPLACED WITH JUMPER	1298	NWL 3-19-74	[illegible] 3-19-74
C	ADDED COMPONENT DESIG. NOS. #NOTE "2." (21)	—	LATHROP 5-28-74	C Spann 6-19-74
D	ADDED FIND NO's 5 & 30 (33)	2635	[illegible] 3-26-77	[illegible] 5-20-77





MTG. DETAIL FOR ITEMS #6, 21, 32 (H)

(C) 2. FOR SCHEMATIC SEE DWG. D6-6233
(A) 1. APPLY VARNISH, ITEM #4, TO BOTH SIDES OF BOARD AFTER ELECTRICAL CHECK.
NOTE:

32	10808	1			SEMICOND., 2N2917
31	10021	1		B4-5620	BOARD, PC
(D) 30	90477	-			QCI 2-51 360 Log Amp. P.C.B. ASM.
29	9873	1			RESISTOR, 1.5M 1/4W 5%
28	9869	1			RESISTOR, 274 OHM 1/4W 1%
27	9863	1			RESISTOR, 7.5K 1/8W 1%
26	9859	1			RESISTOR, 3.83K 1/8W 1%
25	9858	1			RESISTOR, 2.74K 1/8W 1%
24	9856	1			RESISTOR, 1.82K 1/8W 1%
23	5432	1			CAPACITOR, .001MF - 80V 10%
22	9716	1			RESISTOR, 43.2K 1/8W 1%
21	9269	1			SEMICOND., UA 776
20	9183	1			RESISTOR, 232K 1/8W 1%
19	9105	1			RESISTOR, 4.99K 1/8W 1%
18	8355	2			SEMICOND., 741 Mini-DIP
17	8339	1			POT, 100K
16	7886	1			TEST JACK, RED
15	7877	1			RESISTOR, 10M 1/4W 5%
14	7864	2			RESISTOR, 27.4K 1/8W 1%
13	7859	1			RESISTOR, 10K 1/8W 1%
12	7848	2			RESISTOR, 1K 1/8W 1%
11	7843	1			RESISTOR, 100 OHM 1/8W 1%
10	5897	1			THERMISTOR 3K
9	5579	1			POT, 10K
8	5476	1			POT, 20K
7	5398	2			SEMICOND., 1N914
6	4583	1			SEMICOND., 2N3568
(D) 5	90969	-		D6-6233	SCHEMATIC
4	2878	AR			VARNISH
3	2365	AR			SOLDER 60/40
2	2383	AR			WIRE, #22 BARE TINNED COPPER
1	9618				BOARD, LOG AMP PC ASM.

ITEM NO.	PART NO.	NO. REQ.	DRAWING NO.	DESCRIPTION / SPECIFICATION	MODEL	NEXT ASSEMBLY	MFR.
					360	D2-4851	1

TOLERANCES UNLESS SPECIFIED OTHERWISE
FRACTIONS: ± 1/64" DECIMALS: ± 0.005" ANGLES: ± 1/2°

DRAWN BY	CHECKED BY	APPROVED BY	APPROVED BY	SCALE
R. Pari	LATHROP	[illegible]	C. Spann	REF. ONLY
7-24 1973	8-20 1973	9-17 1973	4 19 1974	2X

TITLE: BOARD, LOG AMP PC ASM.

IRD MECHANALYSIS, INC.
COLUMBUS, OHIO

DRAWING NUMBER C2-5686D SHEET 1

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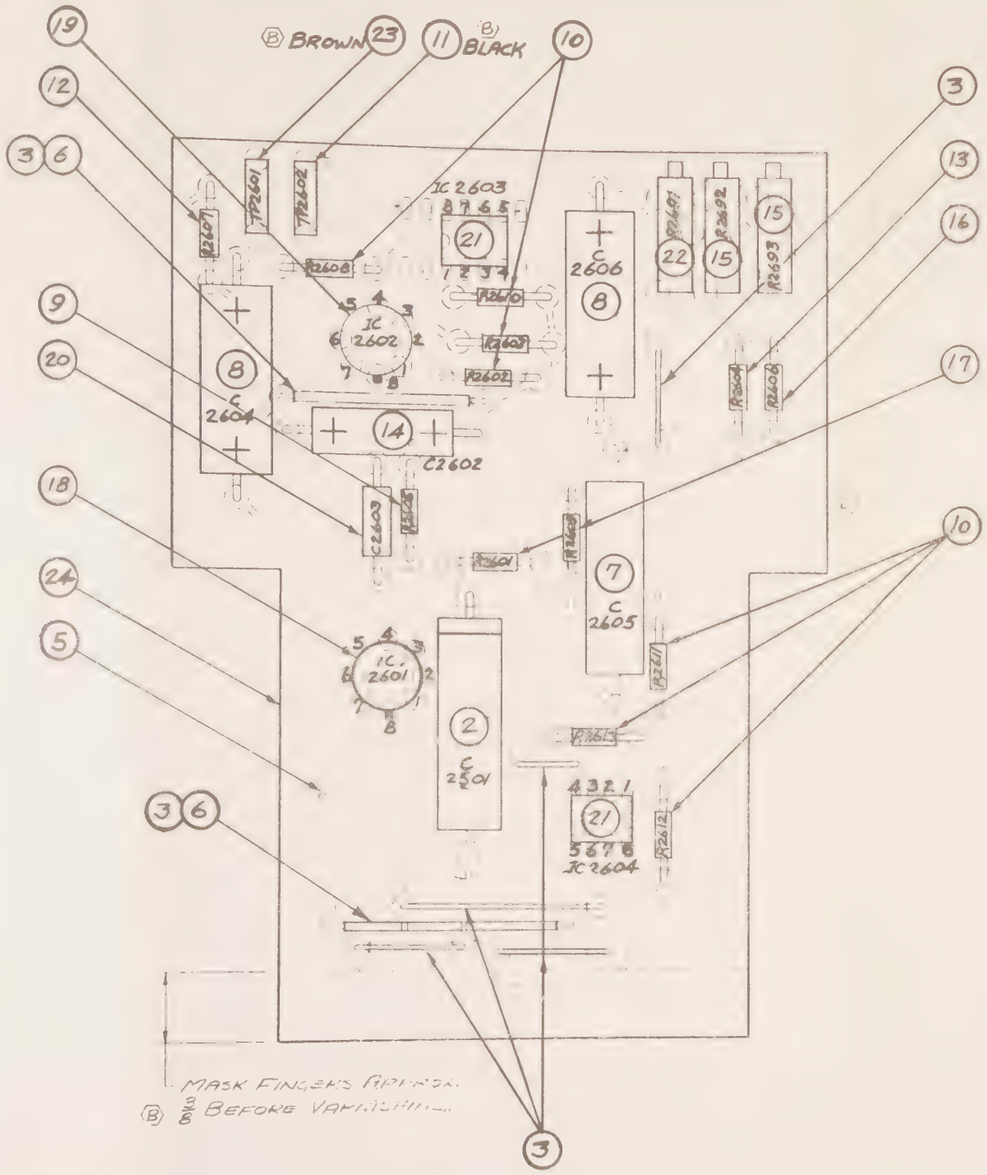
Figure A-8 Log Amplifier PC Board

SCOTT GRAPHICS 9-72 80810

LTR.	REVISION	CHANGE ORDER	C'K'D DATE	APP'D DATE
A	ITEM 16 WAS P/N 9571 & ITEM 22 WAS P/N 9938	~	LATHROP 9-25-73	
B	ADDED MFG. DETAIL DRAWING REFERENCED BOTTOM VIEW ITEMS #18 & 19. DELETED ITEM 6 SPAGHETTI ON 5 JUMPERS	~	NWL 3-6-74	4-4-74
C	REMOVED 3/4Z FROM FIGHT SIDE OF BOARD AS INDICATED	1282	LATHROP 3-18-74	5-1-74
D	ADDED COMPONENT DESIG. NO. : NOTE #2	—	LATHROP 5-28-74	6-20-74
E	ADDED FIND NO.'S 25 & 26	2635		



ITEM NO.	PART NO.	NO. REQ.	DRAWING NO.	DESCRIPTION / SPECIFICATION	MODEL	NEXT ASSEMBLY	NO. REQ.
E 26	90513			QCI-2-87			
E 25	50969	-	D6-6233	SCHEMATIC			
24	10018	/	C6-5616	BOARD, SIG. COND VEL INTEG P.C.			
23	9940	1		JACK, BROWN TEST			
22	8337	1		POT, 5K			
21	9692	2		SEMICOND, 741 CLN			
20	9337	1		CAPACITOR, .0015 MF 80V 10%			
19	9302	1		SEMICOND, BB-3057A/01			
18	9301	1		SEMICOND, BB-3503A			
17	9298	2		RESISTOR, 2.21M 1/8 W 1% CF			
16	9861	1		RESISTOR, 4.02K 1/8 W 1%			
15	8336	2		POT, 1K			
14	8108	1		CAPACITOR, 15 MF 15V			
13	8105	1		RESISTOR, 4.64K 1/8 W 1%			
12	7975	1		RESISTOR, 499 OHM 1/8 W 1%			
11	7885	1		JACK, BLACK TEST			
10	7869	7		RESISTOR, 10K 1/8 W 1%			
9	7847	1		RESISTOR, 750 OHM 1/8 W 1%			
8	5023	2		CAPACITOR, 250 MF 3V			
7	4987	1		CAPACITOR, .033 MF 100V 1%			
6	3398	AR		SPAGHETTI, #24 GA			
5	2878	AR		VARNISH			
4	2365	AR		SOLDER, 60/40			
3	2363	AR		WIRE, #22 GA. BARE TINNED COPPER			
2	1424	1		CAPACITOR, .22 MF 200V			
1	9822			BOARD, SIG. COND PC ASM	360	DZ-5841	1

TOLERANCES UNLESS SPECIFIED OTHERWISE
FRACTIONS ± 1/64" DECIMALS. ± 0.005" ANGLES: ± 1/2°

DRAWN BY J. Z. 8-2 1973 | CHECKED BY LATHROP 9-25 1973 | APPROVED BY [illegible] 9-17 1973 | APPROVED BY [illegible] 9-17 1973 | SCALE REF. ONLY | 2 × SIZE

TITLE: BOARD-SIGNAL CONDITIONER VELOCITY INTEGRATOR P.C. ASM., SC4

IRD MECHANALYSIS, INC.
COLUMBUS, OHIO

DRAWING NUMBER C2-5703 | E | SHEET 1 OF 1

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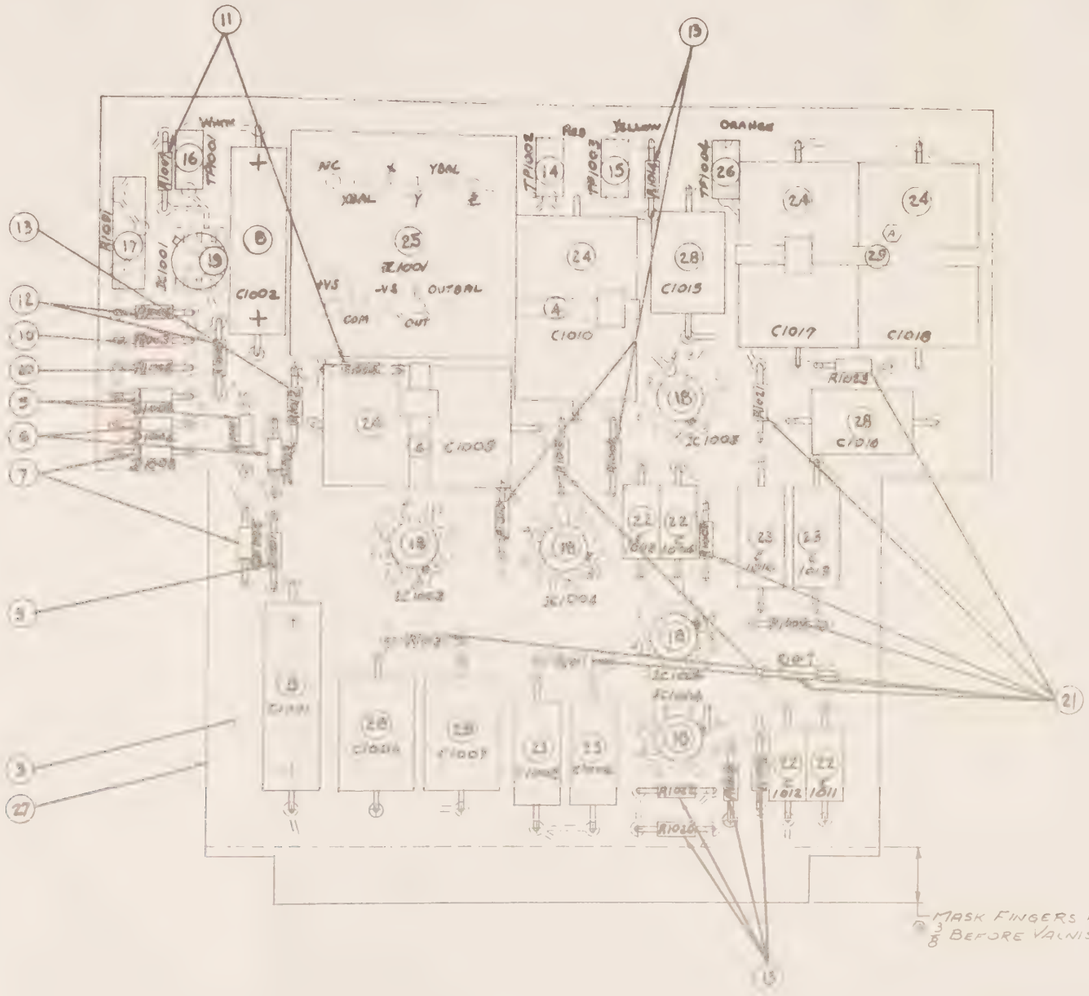
NOTE:
1. APPLY VARNISH, ITEM #5, TO BOTH SIDES OF BOARD AFTER ELECTRICAL CHECK.
2. FOR SCHEMATIC SEE DWG. D6-6233

Figure A-9 Signal Conditioner Velocity Integrator PC Board

LTR	REVISION	CHANGE ORDER	CK'D DATE	APPD DATE
A	ADDED MFG DETAIL & NOTES DELETED 1 P/N 4406 TIE ADDED 1 P/N 4405 TIE	V-	[illegible] 5-19-76	[illegible]
B	ADDED COMPONENT DESIGN NO. & NOTE "L"	—	[illegible] 5-28-76	[illegible]
C	ITEM 19 WAS 8555, 741 MINI DIP	2489	[illegible]	[illegible]
D	ADDED FML # 30+31 [illegible]	2635	[illegible]	[illegible]



(B) 2. FOR SCHEMATIC SEE DWG. D6-6233
(B) 1. APPLY VARNISH, ITEM #3, TO BOTH SIDES OF BOARD AFTER ELECTRICAL CHECK.
NOTE:

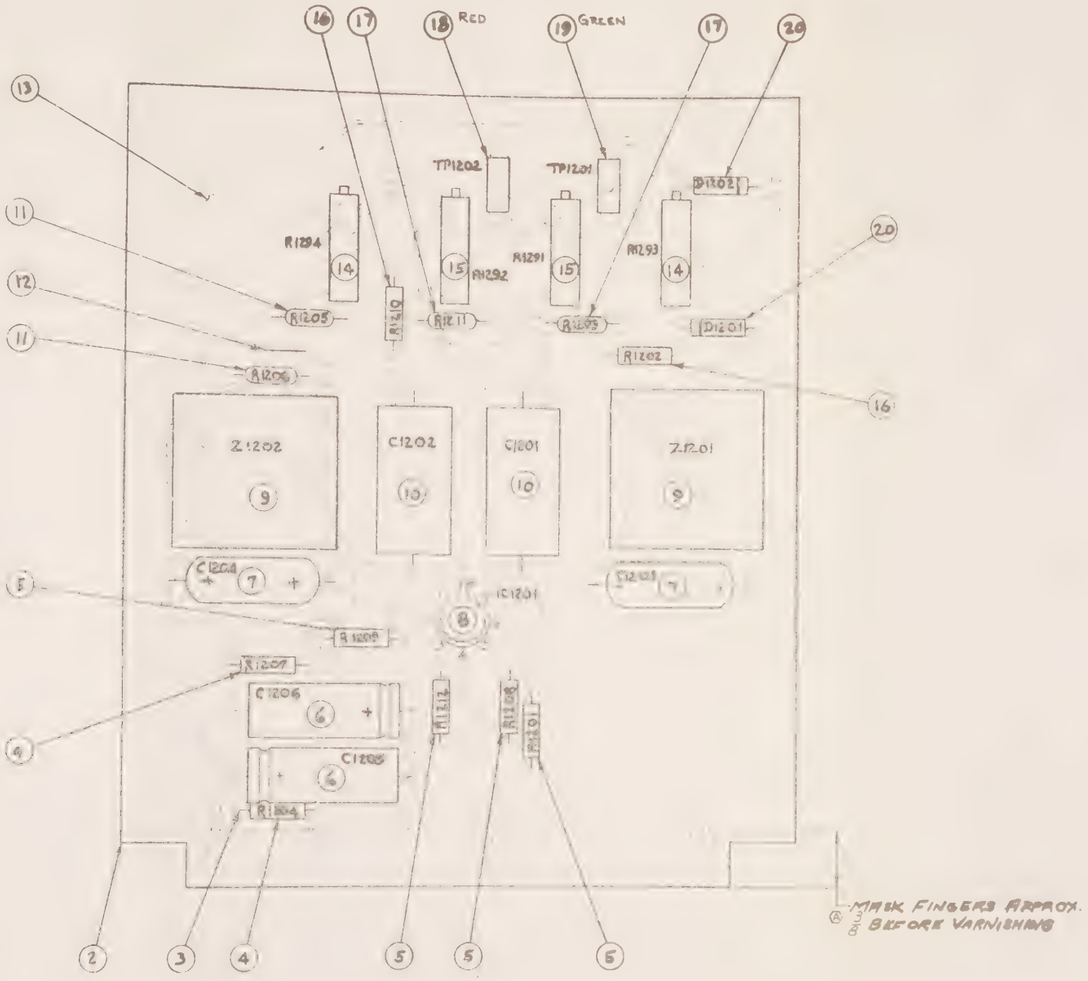
(A) MTG. DETAIL FOR ITEM #18

ITEM NO	PART NO	NO. REQ.	DRAWING NO.	DESCRIPTION / SPECIFICATION
(D)	3	9041C		QC1-2-44 INPUT MULTPLIER & LP FILTER PCB
	30	90969	D6-6233	SCHEMATIC
	[illegible]	[illegible]		TIE-SELF CLINCHING
	[illegible]	4		CAPACITOR, 2MF-50V 5%
	[illegible]	1	C4-5456	BOARD, P.C.
	26	9941	1	TEST JACK, ORANGE
	25	9934	1	SEMICOND., 428K MULTIPLIER
	24	9911	4	CAPACITOR, 10MF-50V 5%
	23	9905	4	CAPACITOR, .47MF-50V 5%
	22	9895	4	CAPACITOR, .15MF-50V 5%
	21	9284	8	RESISTOR, 221K ⅛W 1%
	20	8675	1	RESISTOR, 40.2K ⅛W 1%
(C)	19	14993	1	SEMICOND., CA3140
	18	8554	5	SEMICOND., MC-1458
	17	8338	1	POT, 50K
	16	7889	1	TEST JACK, WHITE
	15	7887	1	TEST JACK, YELLOW
	14	7886	1	TEST JACK, RED
	13	7868	8	RESISTOR, 100K ⅛W 1%
	12	7867	2	RESISTOR, 68.1K ⅛W 1%
	11	7866	2	RESISTOR, 47.5K ⅛W 1%
	10	7864	1	RESISTOR, 27.4K 1/8W 1%
	9	7858	1	RESISTOR, 8.25K ⅛W 1%
	8	5030	2	CAPACITOR, 50MF-25V NP.
	7	4981	2	SEMICOND, IN750A MATCHED PAIR
	6	4980	2	SEMICOND., IN749A MATCHED PAIR
	5	4979	2	SEMICOND., IN747A MATCHED PAIR
(A)	4	4406	2	TIES, SELF CLINCHING
	3	2878	AR	VARNISH
	2	2365	AR	SOLDER 60/40
	1	9610		BOARD, INPUT MULTIPLIER & L.P. FILTER 360 D2-[illegible]

TOLERANCES UNLESS SPECIFIED OTHERWISE
FRACTIONS ± 1/64" DECIMALS ± 0.005" ANGLES ± 1/2°
DRAWN BY [illegible] CHECKED BY [illegible] APPROVED BY [illegible] SCALE PER CIRCLE
7-17-75 7-25-75 7-25-75 2 X
TITLE: BOARD, INPUT MULTIPLIER & L.P. FILTER "A" & "B" P.C. ASM.
IRD MECHANALYSIS, INC. COLUMBUS, OHIO
DRAWING NUMBER D2-5678

Figure A-10 Input Multiplier and Low Pass Filter A-B PC Board

LTR	REVISION	CHANGE ORDER	CK'D DATE	APP'D DATE
A	[illegible]		1-6-74	[illegible]
B	ITEM 16 WAS 7854 - 10K	1268	3-7-74	[illegible]
C	ADD : COMPONENT NOS. & NOTE #2		8-28-74	[illegible]
D	PAD 12 WAS AR READ - FIND # Z1922 ADDED [illegible]	2685	6-18-77	[illegible] 6-30-77



NOTE:
1. APPLY VARNISH, ITEM #13 TO BOTH SIDES OF BOARD AFTER ELECTRICAL CHECK.
2. FOR SCHEMATIC SEE DWG. DG-6233

ITEM NO.	PART NO.	NO. REQ.	DRAWING NO.	DESCRIPTION / SPECIFICATION	MODEL	NEXT ASSEMBLY
22	90471	-		QC1-2-45 DC AMP & OUTPUT MULTIPLIERS PCB		
21	90969	-	DG-6233	SCHEMATIC		
20	5399	2		SEMICOND - IN5231B		
19	9942	1		TEST JACK - GREEN		
18	7886	1		TEST JACK - RED		
17	8244	2		RESISTOR - 1.5K 1/8W 1%		
16	7858	2		RESISTOR - 8.25K 1/8W 1%		
15	8336	2		POT - 1K		
14	5476	2		POT - 20K		
13	2878	AR		VARNISH		
12	2343	.02 FT		WIRE - BARE		
11	7852	2		RESISTOR - 2.21K 1/8W		
10	9909	2		CAPACITOR - 3 MFD - 50V 5%		
9	9935	2		SEMICOND - 432K MULTIPLIER		
8	8554	1		SEMICOND - MC1458		
7	5029	2		CAPACITOR - 5 MFD, 25V NP		
6	5028	2		CAPACITOR - 100 MFD, 25V		
5	7843	4		RESISTOR - 100Ω 1/8W 1%		
4	9902	2		RESISTOR - 51.1Ω 1/8W 1%		
3	2365	AR		SOLDER - 60/40		
2	10015	1	C4-5562	BOARD - P.C.		
1	9612			BOARD - DC AMP & OUTPUT MLT PC Assm. 3		

TOLERANCES UNLESS SPECIFIED OTHERWISE
FRACTIONS ± 1/64 DECIMALS ± 0.005" ANGLES ± 1/2°

DRAWN BY	CHECKED BY	APPROVED BY	APPROVED BY	SCALE
R. CARLISLE	[illegible]	[illegible]	[illegible]	REF. ONLY
7-18-73	7-18-73	[illegible]	[illegible]	2 X

TITLE: BOARD - D.C. AMP & OUTPUT MULTIPLIERS P.C.

IRD MECHANALYSIS, INC.
COLUMBUS, OHIO

DRAWING NUMBER DC5-75

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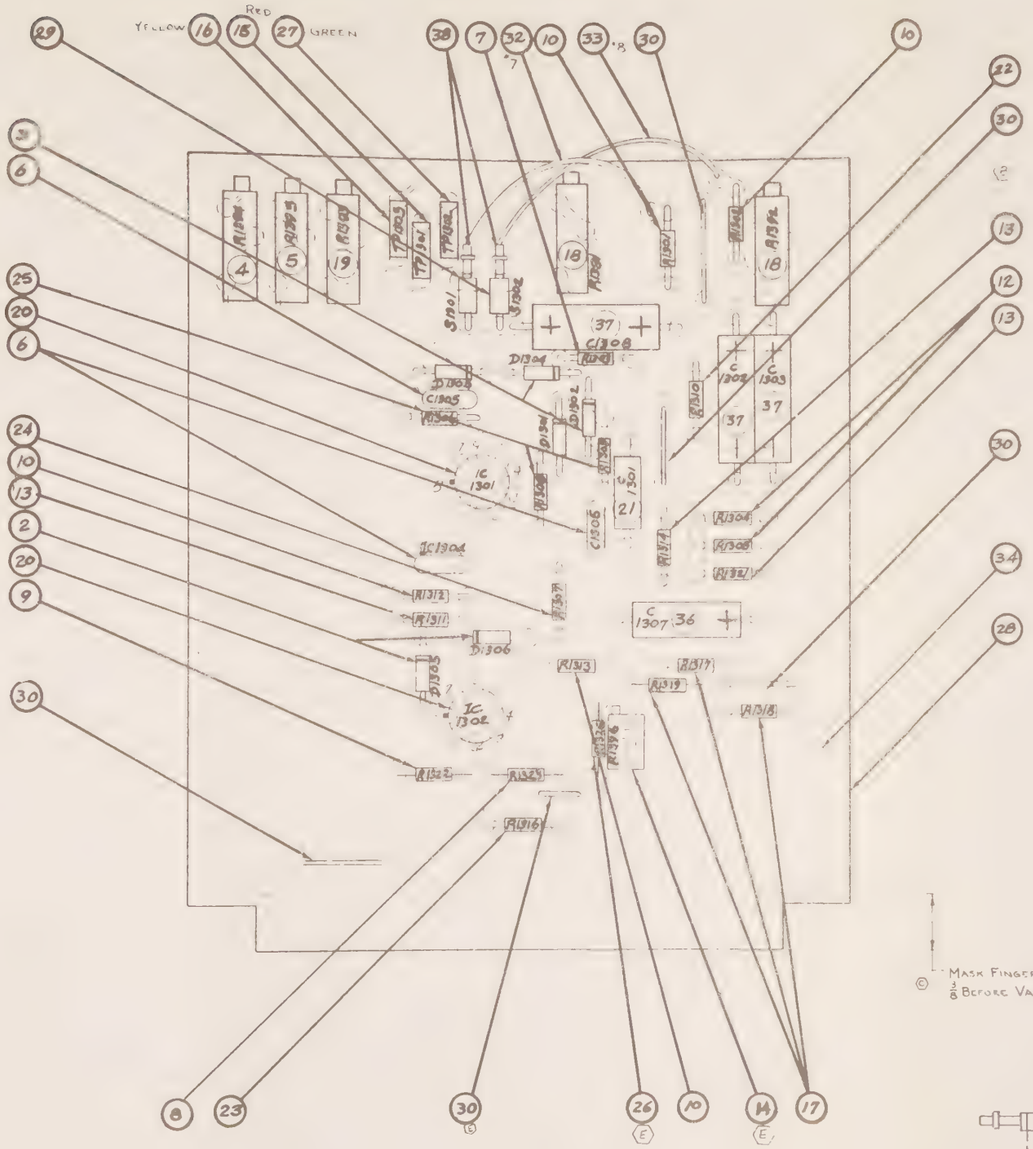
Figure A-11 DC Amplifier and Output Multiplier PC Board

LTR	REVISION	CHANGE ORDER	
A	ITEM "L PT# 10921 L. REQ PT# 1401	—	7-2-
B	REMOVED ITEM "11 PT# 7863 ADDED DWG NO. TO ITEM "28	—	LATHROP 9-25-78
C	ADDED NOTE "2" & NOTES DELETED ITEM 35 SPAGHETTI	~	NWL 3-5-79
D	ADDED COMPONENT DESIG NO. & NOTE "2	—	LATHROP 5-28-79
E	ITEM "26 WAS 9873; ITEM "14 WAS BLANK REVISED ITEM AS SHOWN PER ARTWORK.	1366	LATHROP 7-2-79
F	FIND# 32-33 REQ'D WAS INCHES FIND# 30 REQ'D WAS AR - FIND# 39, 40 +41 ADDED (MANUAL MERGE)	2635	APPROVED 9-18-79



MASK FINGERS APPROX. 3/8 BEFORE VARNISHING.

FORMING DETAIL FOR ITEM #29

MTG. DETAIL FOR ITEM #20

	ITEM NO	PART NO	NO REQ	DRAWING NO	DESCRIPTION / SPECIFICATION	MODEL	NEXT ASSEMBLY
F	41	90472	-		2C1-2-46 OUTPUT AMP ACT. RECT IKC SIN/COS OSC.		
F	40	90969	-	D6-6233	SCHEMATIC		
F	39	90964	-	D1-5848	CUT-LIST, WIRE		
	38	5209	2		CONNECTOR, COMBO JACK & PLUG		
	37	5029	5		CAPACITOR, 5 MF 25 V NP		
	36	5626	1		CAPACITOR 10 MF 25 V		
	35						
	34	2878	AR		VARNISH		
F	33	2432	32 INCHES		WIRE #22 GA STR INS BLACK (B)		
F	32	2429	27 INCHES		WIRE #22 GA STR INS RED (7)		
	31	2365	AR		SOLDER 60/40		
F	30	2969	32 INCHES		WIRE #22 GA. BARE TINNED COPPER		
	29	10277	2		JACK, TEST		
B	28	10016	1	C4-5842	BOARD, OUTPUT AMP PC		
	27	9942	1		JACK GREEN TEST		
B	26	9868	1		RESISTOR 66.9K 1/4W 1%		
	25	9866	3		RESISTOR 191K 1/8 W 1%		
	24	9805	1		RESISTOR, 182 K 1/8 W 1%		
	23	9858	1		RESISTOR, 2.74K 1/8 W 1%		
	22	9856	1		RESISTOR 1.82 K 1/8 W 1%		
	21	7336	1		CAPACITOR, .033 MF 80V 5%		
	20	8554	2		SEMICOND, MC-1458		
	19	8355	1		POT, 100 K		
	18	8337	2		POT, 5 K		
	17	8264	3		RESISTOR 1.5K 1/8 W 1%		
	16	7857	1		JACK, YELLOW TEST		
	15	7856	1		JACK RED TEST		
E	14	9630	1		POT 200K		
	13	7869	3		RESISTOR, 100K 1/8 W 1%		
	12	7866	2		RESISTOR, 47.5K 1/8 W 1%		
B	11						
	10	7859	4		RESISTOR, 10K 1/8 W 1%		
	9	7857	1		RESISTOR 6.81K 1/8 W 1%		
	8	7856	1		RESISTOR 4.75K 1/8 W 1%		
	7	7848	1		RESISTOR, 1K 1/8 W 1%		
A	6	1671	5		CAPACITOR, 820 PF 1%		
	5	5579	1		POT, 10K		
	4	5476	1		POT, 20K		
	3	5399	4		SEMICOND, IN5231B		
	2	5398	2		SEMICOND, IN914		
	1	9613			BOARD, OUTPUT AMP PC ASSY	360	D2-4851

TOLERANCES UNLESS SPECIFIED OTHERWISE
FRACTIONS: ± 1/64" DECIMALS: ± 0.005" ANGLES: ± 1/2°

DRAWN BY	CHECKED BY	APPROVED BY	APPROVED BY	SCALE
JWC 7-12-78	J.A. 7-24-78	R. 7/31/78	C. Hahn 8-7-78	REF. ONLY

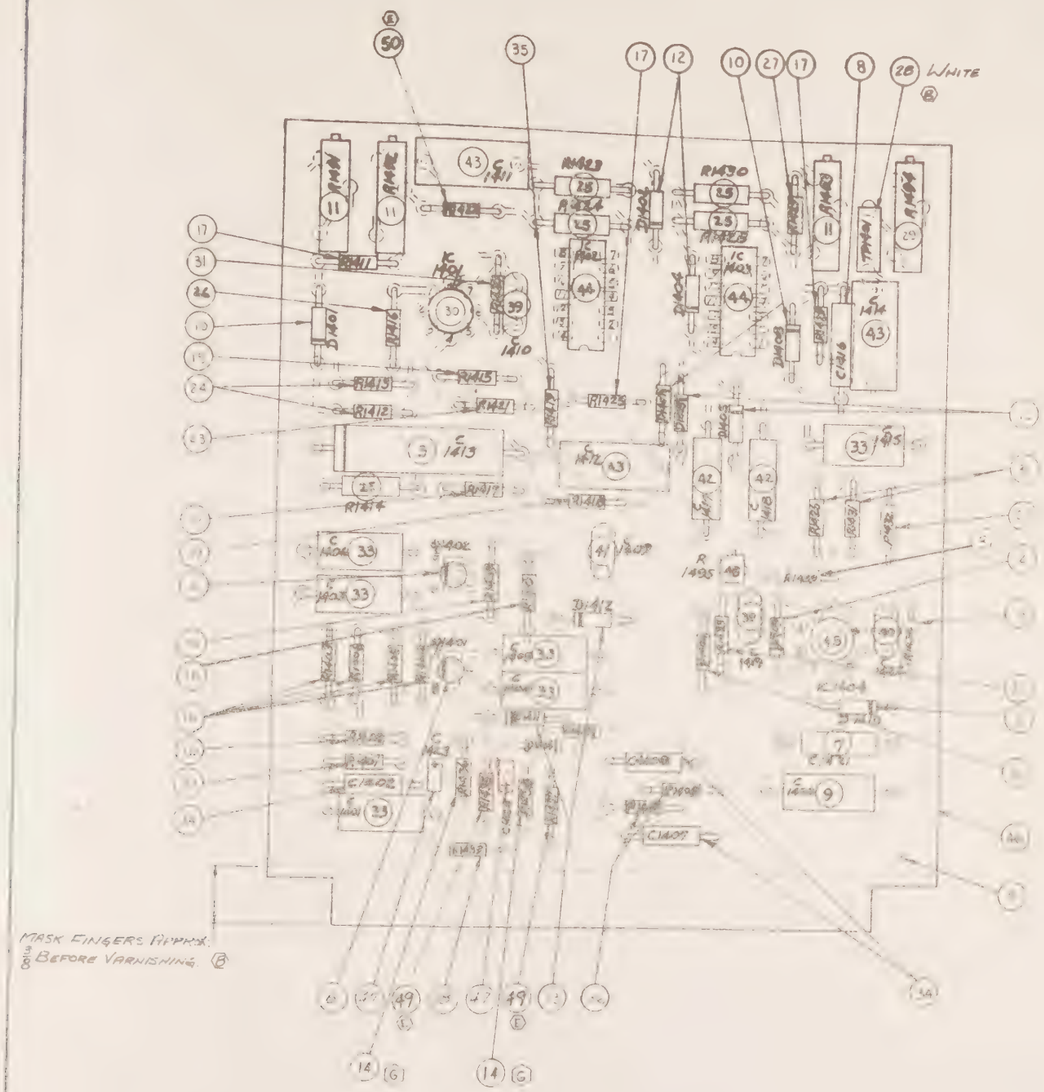
TITLE: BOARD-OUTPUT AMP ACT. RECT. 1KC SIN/COS OSC. P.C. ASM

IRD MECHANALYSIS, INC.
COLUMBUS, OHIO

DRAWING NUMBER D2-5680 E

NOTES:
1. FOR SCHEMATIC SEE DWG. D6-6233 SHEET 10
2. APPLY VARNISH, ITEM #34, TO BOTH SIDES OF BOARD AFTER ELECTRICAL CHECK.

Figure A-12 Output Amplifier Active Rectifier, 1 KC Sin/Cosine Oscillator PC Board



LTR.	REVISION	CHANGE ORDER	CK'D DATE	APP'D DATE
A	ADDED (2) PT#5396 ITEM #47 & (1) PT#7959 ITEM #18. RELOCATED ITEM #41	—	LATHROP 9-27-79	
B	ADDED MTG. DETAIL & NOTES	~	3-6-79	
C	ADDED COMPONENT DESIG. NO. & NOTE #2.	—	LATHROP 5-28-76	
D	ITEM #2 WAS PT#1980. ITEM #7 WAS (1) REQ'D. ADDED ITEM #46 PT#3630.	2137	7L 6-7-77	
E	ITEM 12 P/N WAS 5534. ITEM 14 NO. REQ. WAS 4. ITEM 27 NO. REQ WAS 2. ITEM #49 & 50 ADDED.	2555	7L 3-11-77	
F	ADDED END # 5192	2635		
G	R1436 & R1438 CALLOUTS WERE #49	2696	7L	

ITEM NO.	PART NO.	NO. REQ.	DRAWING NO.	DESCRIPTION / SPECIFICATION
(F)	52	90473			QC1-2-47 PHASE METER CIRCUIT PCB ASM
	51	90969	-	D6-6233	SCHEMATIC
(E)	50	7876	1		RESISTOR 4.7M 1/4W 5% CC
(E)	49	12198	2		RESISTOR, 65Ω 1/4W CC 5%
(C)	48	9630	1		POT 200K
(A)	47	5530	2		CAP., MYLAR, 0.22 MF - 50 V TANTALUM
	46	10017	1	C4-5608	BOARD, PC
	45	9933	1		SEMICOND. 8017C
	44	9931	2		SEMICOND., MC-1709 CL
	43	9899	3		CAPACITOR, .47MF - 200V 10%
	42	9335	2		CAPACITOR, .15 MF - 50V 5%
(B)	41	9882	1		CAPACITOR, 270 PF
	40	9881	1		CAPACITOR, 20 PF
	39	9880	2		CAPACITOR, 24 PF
	38	9875	1		RESISTOR, 4.7M 1/4 W 5%
	37	[illegible]	2		RESISTOR, 191K 1/8 W 1%
	36	[illegible]	4		RESISTOR, 182K 1/8 W 1%
	35	[illegible]	1		RESISTOR, 66.5K 1/8 W 1%
	34	[illegible]	3		CAPACITOR .001MF - 80V 10%
	33	[illegible]	6		CAPACITOR .1MF - 80V 10%
	32	[illegible]	1		RESISTOR, 20K 1/8 W 1%
	31	[illegible]	2		RESISTOR, 1M 1/8 W 1%
	30	[illegible]	1		SEMICOND. MC-1458
	29	[illegible]	1		POT, 5K
	28	[illegible]	1		TEST JACK, WHITE
(E)	27	[illegible]	1		RESISTOR 10M 1/4W 5%
	26	[illegible]	1		RESISTOR, 2.7M 1/4W 5%
	25	[illegible]	5		RESISTOR, 562K 1/8W 1%
	24	[illegible]	2		RESISTOR, 475K 1/8W 1%
	23	7563	1		RESISTOR, 100K 1/8W 1%
	22	7861	2		RESISTOR 68.1K 1/8W 1%
	21	7866	1		RESISTOR 47.5K 1/8W 1%
	20	7863	1		RESISTOR 22.1K 1/8W 1%
	19	7860	1		RESISTOR, 15K 1/8W 1%
(A)	18	7859	2		RESISTOR, 10K 1/8W 1%
	17	7857	3		RESISTOR, 6.81K 1/8W 1%
	16	7854	4		RESISTOR, 3.32K 1/8W 1%
	15	7848	2		RESISTOR, 1K 1/8W 1%
(E)	14	7844	2		RESISTOR, 215 OHM 1/8W 1%
	13	5562	4		SEMICOND. 1N4742A
(E)	12	16120	1		SEMICOND., 1M6.2 ZS5D1 (MATCHED SET OF 4)
	11	5476	3		POT, 20K
	10	5398	4		SEMICOND., 1N914
	9	5042	1		CAPACITOR, .022 MF - 80V
	8	5040	1		CAPACITOR, .01MF - 200V
	7	5039	1		CAPACITOR, .0047 MF - 200V.
	6	4826	2		SEMICOND., 2N3391
	5	[illegible]	AR		VARNISH
	4	2365	AR		SOLDER 60/40
	3	1424	1		CAPACITOR .22 M.F. 200V
(D)	2	5398	2		SEM.COND IN 914
	1	9614	1		BOARD, PHASE METER CIRCUIT PC ASM	360	D2-4851	1

TOLERANCES UNLESS SPECIFIED OTHERWISE
FRACTIONS: ± 1/64" DECIMALS: ± 0.005" ANGLES: ± 1/2°

DRAWN BY	CHECKED BY	APPROVED BY	APPROVED BY	SCALE
R. Mac	LATHROP	[illegible]	[illegible]	REF. ONLY

TITLE: BOARD-PHASE METER CIRCUIT PC ASM

IRD MECHANALYSIS, INC.
COLUMBUS, OHIO

DRAWING NUMBER D2-5683 G

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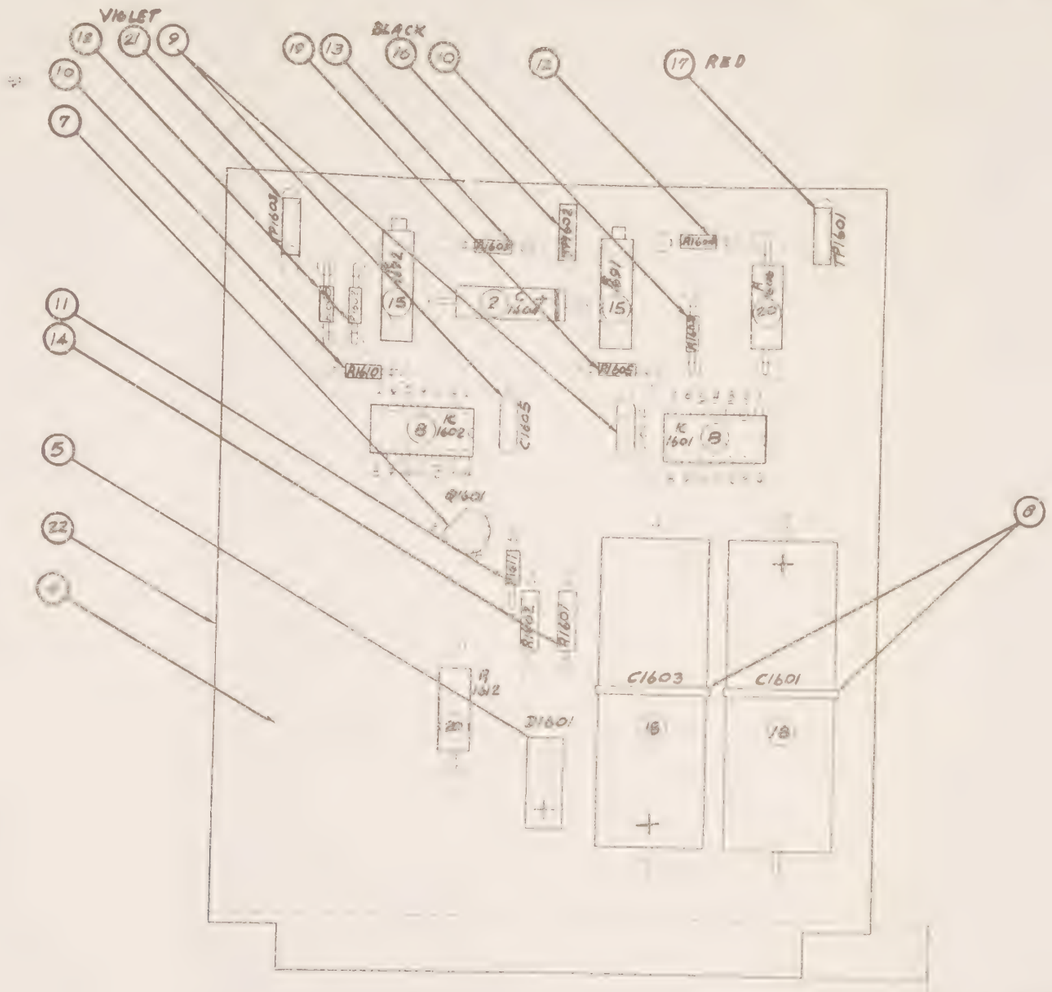
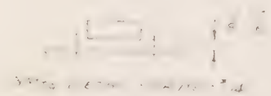
NOTES:
1. APPLY VARNISH, ITEM #5, TO BOTH SIDES OF BOARD AFTER ELECTRICAL CHECK. (B)
2. FOR SCHEMATIC SEE DWG. D6-6233 (C)

Figure A-13 Phase Meter Circuit PC Board

LTR	REVISION	CHANGE ORDER	CK'D DATE	APP'D CATE
A	ADDED MFG. DETAILS AND N...	~	6-74	
B	ADDED COMPONENT DESIG. NO. & NOTE #2	—	5-29-74	
C	ADDED FIND # 23+24 ITEM #17 MISSING	2635	5-10-77	





ITEM NO	PART NO	NO REQ	DRAWING NO	DESCRIPTION / SPECIFICATION
	10-73			QC1-2-49 ±15V POWER SUPPLY PCB ASM.
	90769	-	D6-6233	SCHEMATIC
	10019	1	C4-5652	BOARD, ±15V POWER SUPPLY, P.C. ASM.
	9044	1		JACK, VIOLET TEST
	[illegible]	1		RESISTOR, 1 OHM 2 W 5%
	[illegible]	1		RESISTOR 2.55K 1/8 W 1%
	[illegible]	2		CAPACITOR 500MF 50V
	9045	1		JACK, RED TEST
	[illegible]	1		JACK, BLACK TEST
	[illegible]	2		1/2T 50Ω OHM
	[illegible]	2		RESISTOR 1.5 OHM 1/2 W 5%
	[illegible]	1		RESISTOR 4.12K 1/8 W 1%
	[illegible]	5		RESISTOR, 3.01K 1/8 W 1%
	[illegible]	1		RESISTOR 2.21K 1/8 W 1%
10	7947	2		RESISTOR 1.21K 1/8 W 1%
9	9027	2		CAPACITOR 100 PF
8	[illegible]	2		SEMICOND. 1123-6
7	[illegible]	1		SEMICOND 2N5658
6	4005	2		TIES, SELF CONTAINING
5	2005	1		SEMICOND, FW 250
4	2878	AR		VARNISH
3	2360	AR		SOLDER 60/40
2	1445			CAPACITOR .047 MF 200V
1	2616			BOARD ±15V POWER SUPPLY P.C. ASM.

560	D2-4851	1
MODEL	NEXT ASSEMBLY	NO. REQ'D

TOLERANCES UNLESS SPECIFIED OTHERWISE
FRACTIONS ± 1/64" DECIMALS ± 0.005 ANGLES ± 1/2°

DRAWN BY	CHECKED BY	APPROVED BY	APPROVED BY	SCALE
				REF ONLY

TITLE: BOARD-±15V POWER SUPPLY P.C. ASM.

IRD MECHANALYSIS, INC.
COLUMBUS, OHIO

DRAWING NUMBER D2-5681 C SHEET 1 OF 1

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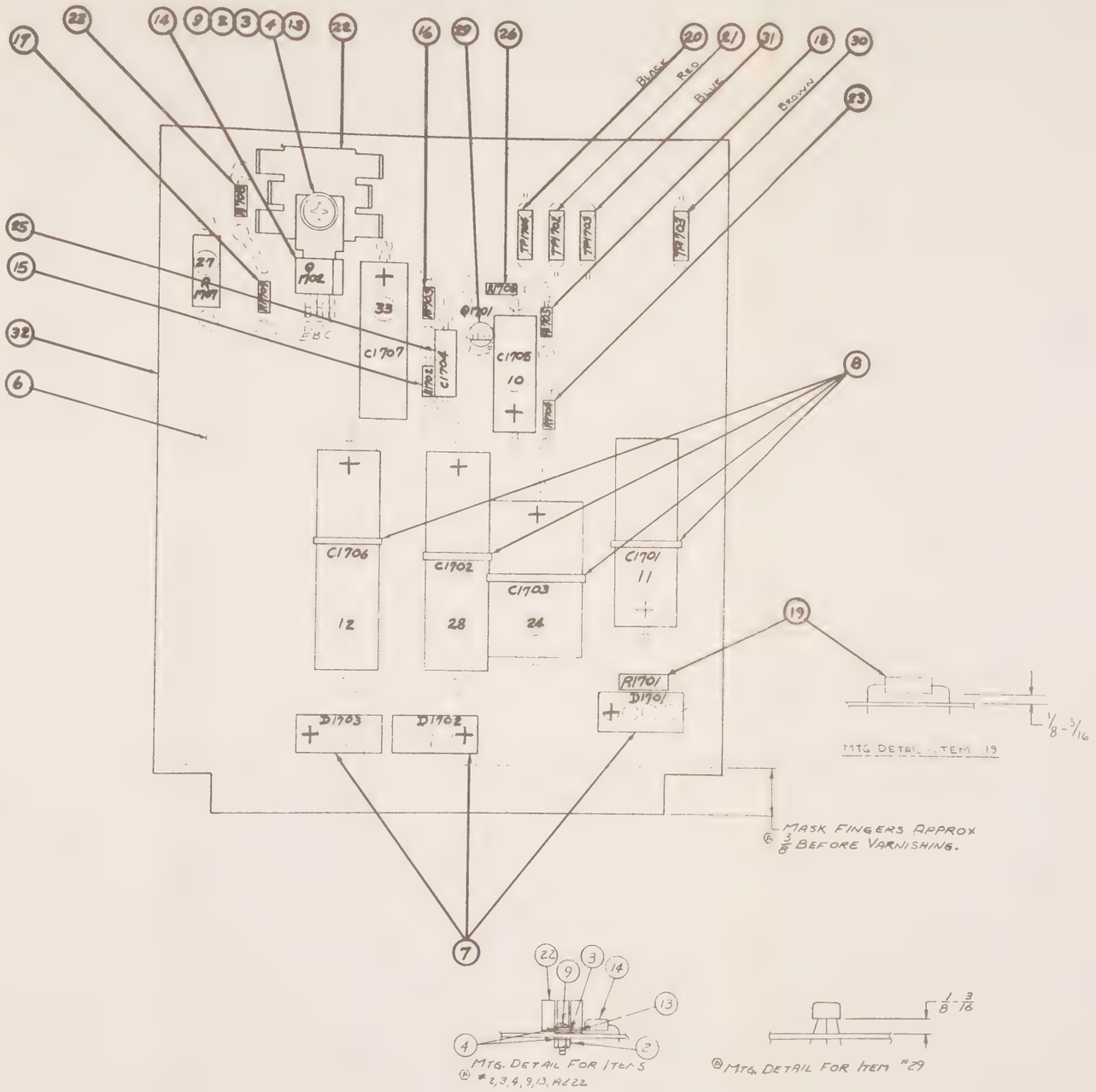
(B) 2. FOR SCHEMATIC SEE DWG. D6-6233
(A) 1. APPLY VARNISH, ITEM #4, TO BOTH SIDES OF BOARD AFTER ELECTRICAL CHECK
NOTE:

(B) MTG DETAIL FOR ITEM #7

Figure A-14 ±15 Volt Power Supply PC Board

LTR.	REVISION	CHANGE ORDER	CK'D DATE	APP'D DATE
A	ADDED MTG DETAILS & NOTES	—	NVC 2-6-74	
B	ADDED COMPONENT DESIG. NO & NOTE #2 (87)	—	LATHROP 5-28-74	
C	ADDED FIND # 34 + 35 (DRAWN TO MASTER)	2638	5-18-77	



ITEM NO	PART NO	NO REQ	DRAWING NO	DESCRIPTION / SPECIFICATION	MODEL	NEXT ASSEMBLY	NO. USED
(C) 35	90476	-		QCI-Z-50 25V UNREG & 5V POWER SUPPLY PCB			
34	90969	-	D6-6233	SCHEMATIC			
33	10565	1		CAPACITOR, 250 MF 12V			
32	10020	1	C4-5603	BOARD, 25V UNREG & 5V POWER SUPPLY P.C.			
31	9943	1		JACK, BLUE TEST			
30	9940	1		JACK, BROWN TEST			
29	9927	1		SEMICOND, D13V1			
28	9913	1		CAPACITOR, 50 MF 150V			
27	9876	1		RESISTOR, 47 OHM 2W 5%			
26	9716	1		RESISTOR, 43.2K 1/8 W 1%			
25	9342	1		CAPACITOR, .1 MF 80V 10%			
24	8611	1		CAPACITOR, 250 MF 50V			
23	8264	2		RESISTOR, 1.5K 1/8 W 1%			
22	7902	1		SINK, HEAT			
21	7886	1		JACK, RED TEST			
20	7885	1		JACK, BLACK TEST			
19	7879	1		RESISTOR, 1.5 OHM 1½ W 5%			
18	7868	1		RESISTOR, 100K 1/8 W 1%			
17	7859	1		RESISTOR, 10K 1/8 W 1%			
16	7849	1		RESISTOR, 1.21K 1/8 W 1%			
15	7848	1		RESISTOR, 1K 1/8 W 1%			
14	7832	1		SEMICOND, D4004			
13	5609	AR		COMPOUND, THERMAL			
12	5325	1		CAPACITOR, 1000 MF 15V			
11	5324	1		CAPACITOR, 500 MF 25V			
10	5034	1		CAPACITOR, 50 MF 50V			
9	4768	1		SCREW, 4-40 × 5/16 PPHM			
8	4406	4		TIES, SELF CLINCHING			
7	3565	3		SEMICOND, FW200			
6	2878	AR		VARNISH			
5	2365	AR		SOLDER, 60/40			
4	1907	2		WASHER, #4 IS LOCK			
3	1888	1		WASHER, #4 PLAIN			
2	1871	1		NUT, #4-40			
1	9617			BOARD, 25V UNREG P.C. ASM.	360	D2-4851	1

TOLERANCES UNLESS SPECIFIED OTHERWISE: FRACTIONS ± 1/64" DECIMALS ± 0.005" ANGLES ± 1/2°

DRAWN BY: [illegible] 7-23-73 | CHECKED BY: MATHROP 8-10-73 | APPROVED BY: [illegible] 9-7-73 | APPROVED BY: [illegible] 11-9-73 | SCALE: REF. ONLY 2×SIZE

TITLE: BOARD-25V UNREG 5V POWER SUPPLY P.C. ASM

IRD MECHANALYSIS, INC. COLUMBUS, OHIO

DRAWING NUMBER D2-5682 C

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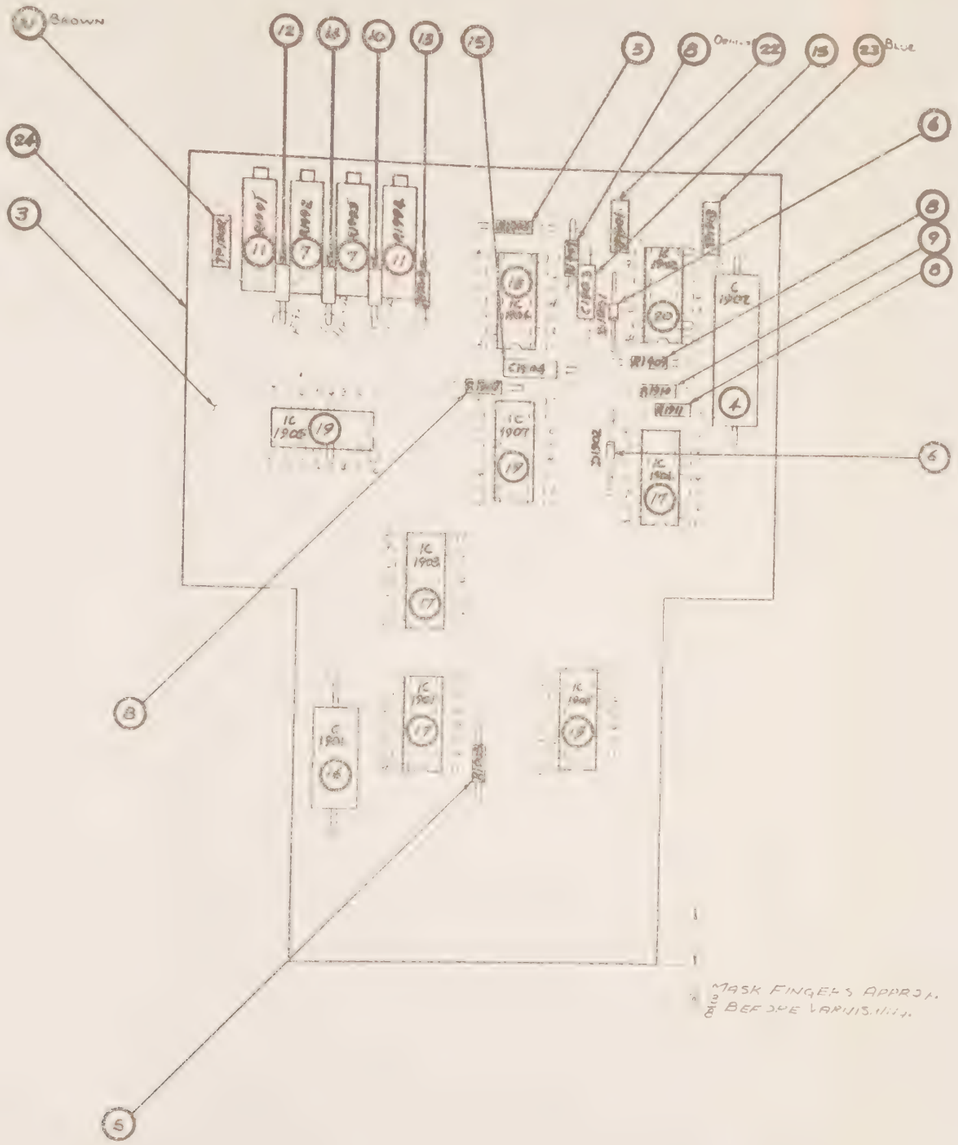
(B) 2. FOR SCHEMATIC SEE DWG D6-6233
(A) 1. APPLY VARNISH, ITEM #6, TO BOTH SIDES OF BOARD AFTER ELECTRICAL CHECK.

NOTES:

Figure A-15 25 Volt Unregulated and 5 Volt Power Supply PC Board

LTR	REVISION	CHANGE ORDER	CK'D DATE	APP'D DATE
A	ADDED NOTES & TEST POINT COLORS	~	NULL 3-6-74	
B	ADDED COMPONENT DESIG. NO # NOTE #2	—	11-8-74	
C	ITEM 7 WAS 3 REQ'D.; ITEM 10 WAS PN 8266, 12 PC; ITEM 11 WAS 1 REQ'D.	1324	4-25-76	
D	ADDED FIND NOS. 25 + 26	2635	4-18-77	4-26-77



ITEM NO.	PART NO.	NO. REQ.	DRAWING NO.	DESCRIPTION / SPECIFICATION	MODEL	NEXT ASSEMBLY	REF.
(D)	26	90478	-		QCI 2-52 DIGITAL SWEEP PCB ASM.		
(D)	25	90969	-	D6-6233	SCHEMATIC		
	24	10022	1	CA-5614	BOARD, DIGITAL SWEEP M.C.		
	23	9943	1		JACK, BLUE TEST		
	22	9941	1		JACK, ORANGE TEST		
	21	9940	1		JACK, BROWN TEST		
	20	9925	1		SEMICOND, MC-667P		
	19	9926	3		SEMICOND CD-4017 AE		
	18	9926	1		SEMICOND CD-4013 AE		
	17	9923	3		SEMICOND, CD-4001 AE		
	16	9905	1		CAPACITOR, .47 MF 50V 5%		
	15	9632	2		CAPACITOR, .001 MF 50V 10%		
	14	9273	1		RESISTOR, 32.4K 1/8W 1%		
	13	9272	1		RESISTOR 54.9K 1/8W 1%		
	12	8591	1		RESISTOR, 97.6K 1/8W 1%		
(C)	11	8338	2		POT, 50K		
(C)	10	7860	1		RESISTOR, 15K 1/8W 1%		
	9	7866	1		RESISTOR, 47.5K 1/8W 1%		
	8	7863	4		RESISTOR, 22.1K 1/8W 1%		
(C)	7	5476	2		POT, 20K		
	6	5398	2		SEMICOND, IN 914		
	5	3584	2		RESISTOR, 1M 1/4W 5%		
	4	4987	1		CAPACITOR, .033 MF 100V 1%		
	3	2879	AR		VARNISH		
	2	2366	AR		SOLDER, 60/40		
	1	9619			BOARD, DIG. SWEEP PC. ASM.	560	D2-4851 1

TOLERANCES UNLESS SPECIFIED OTHERWISE
FRACTIONS ± 1/64" DECIMALS: .X ± .1 .XX ± .05 ANGLES: ± 1/2°

DRAWN BY: CHECKED BY: APPROVED BY: APPROVED BY: SCALE: REF. ONLY

7-30-73 9-27-73 10-4-73 10-4-73 1/2" = 1.00

TITLE: BOARD-DIGITAL SWEEP PC. ASM.

IRD MECHANALYSIS, INC. COLUMBUS, OHIO

DRAWING NUMBER D2-5693 D SHEET

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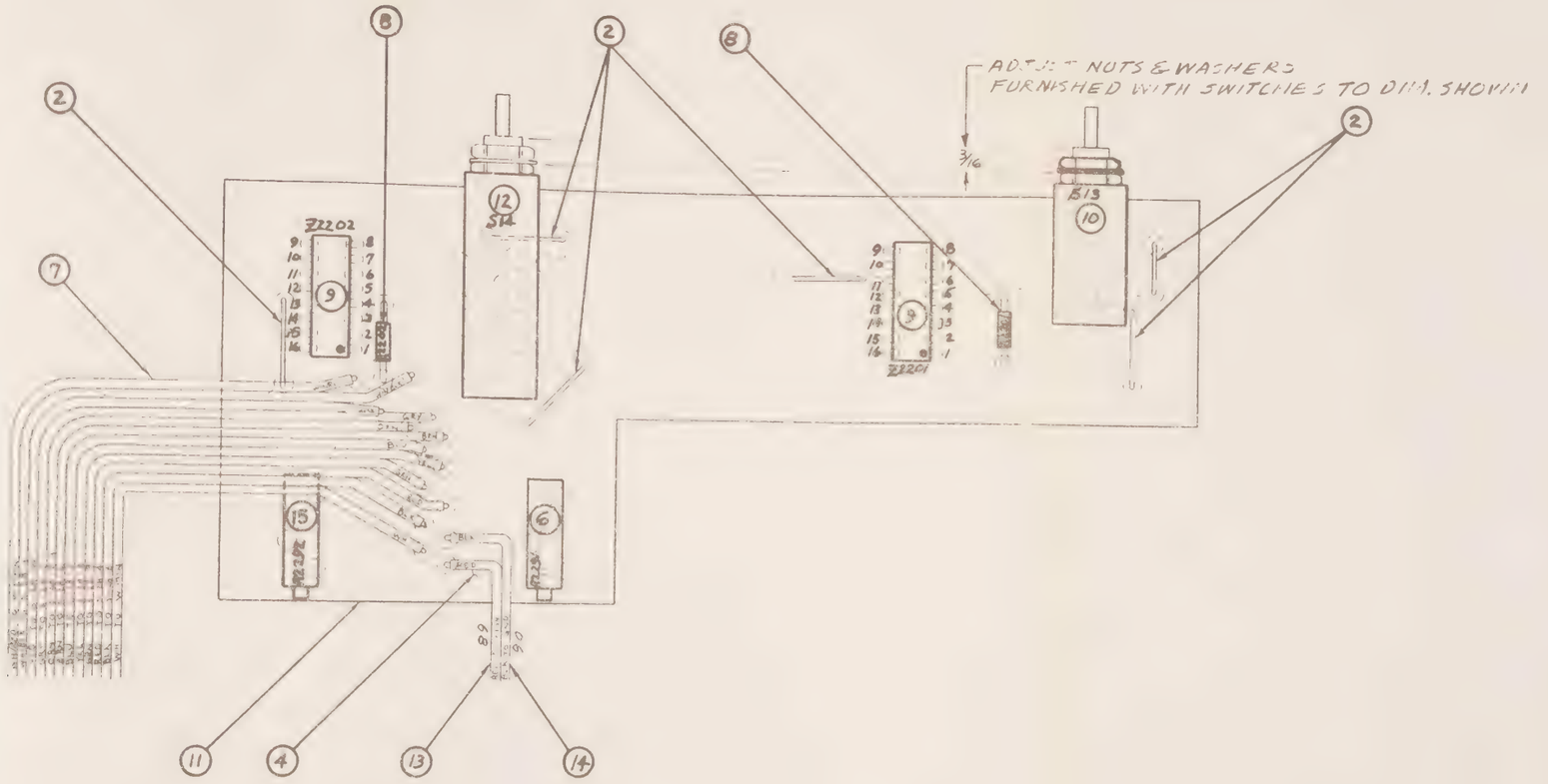
NOTE:
1. APPLY VARNISH, ITEM #3, TO BOTH SIDES OF BOARD AFTER ELECTRICAL CHECK.
2. FOR SCHEMATIC SEE DWG. D6-6233

Figure A-16 Digital Sweep PC Board

LTR	REVISION	CHANGE ORDER	CKD DATE	APPD DATE
A	ADDED ITEMS 3, 4 & CUTLIST	~	LATHROP 9-21-73	
B	REMOVED CUTTING LIST	~	LATHROP 12-28-73	
C	ADDED NOTE VARNISH ETC, DO DELETED ITEMS; PARALLEL TI ADDED NOT ADJ. NOTE & DIM.	~	LATHROP 3-11-74	
D	ADDED COMPONENT DESIG. NO & NOTE #2.	—	LATHROP 5-28-74	
E	1. ADDED ITEM 15. 2. ITEM 6 WAS 2 REQD.	1857	LATHROP 9-30-75	
F	ADDED FIND NO'S. 16 + 17 FIND NO. 2 WAS AR REQ'D. FIND NO'S 13 + 14 REQD WAS INCHES DELETED DRAWING NO'S ON FIND NO'S. 13 + 14	2635		



ITEM NO.	PART NO.	NO. REQ.	DRAWING NO.	DESCRIPTION / SPECIFICATION
F 17	90969	-	D6-6233	SCHEMATIC
F 16	90964	-	D1-5848	CUT-LIST WIRE
E1 15	5476	1		POT 20K #77PR20K
F 14	2430	1.5FT		WIRE, 22GA. STR. INS BLK.
F 13	2429	1.5NT		WIRE, 22GA. STR. INS. RED
12	10975	1		SWITCH, 2P 9 POS. R.C. MTG.
11	10002	1	B4-5610	BOARD, DIGITAL SWEEP FREQ. LIMIT, P.C.
10	9991	1		SWITCH, 1P 9 POS. R.C. MTG.
9	9879	2		RESISTOR, NETWORK
8	7848	2		RESISTOR, 1K 1/8 W 1%
7	11234	1	B4-5821	CABLE, #22 GA. 12 COND.
E2 6	5579	1		POT, 10K
C 5				
4	2878	AR		VARNISH
3	2365	AR		SOLDER, 60/40
F 2	2363	7FT		WIRE, #22 GA. BARE TINNED COPPER
1	10009			BOARD, DIG. SWEEP FREQ. PC PWA 360 D2-4B4-2

TOLERANCES UNLESS SPECIFIED OTHERWISE: FRACTIONS ± 1/64" DECIMALS ± 0.005" ANGLES ± 1/2°

DRAWN BY: [illegible] 7-31-73 | CHECKED BY: LATHROP 9-27-1973 | APPROVED BY: [illegible] 10-4-1973 | APPROVED BY: [illegible] 10-4-1973 | SCALE: REF. ONLY | 2X SIZE

TITLE: BOARD - DIGITAL SWEEP FREQUENCY LIMIT P.C. ASSY.

IRD MECHANALYSIS, INC. COLUMBUS, OHIO

DRAWING NUMBER D2-5697 F 1 OF 1

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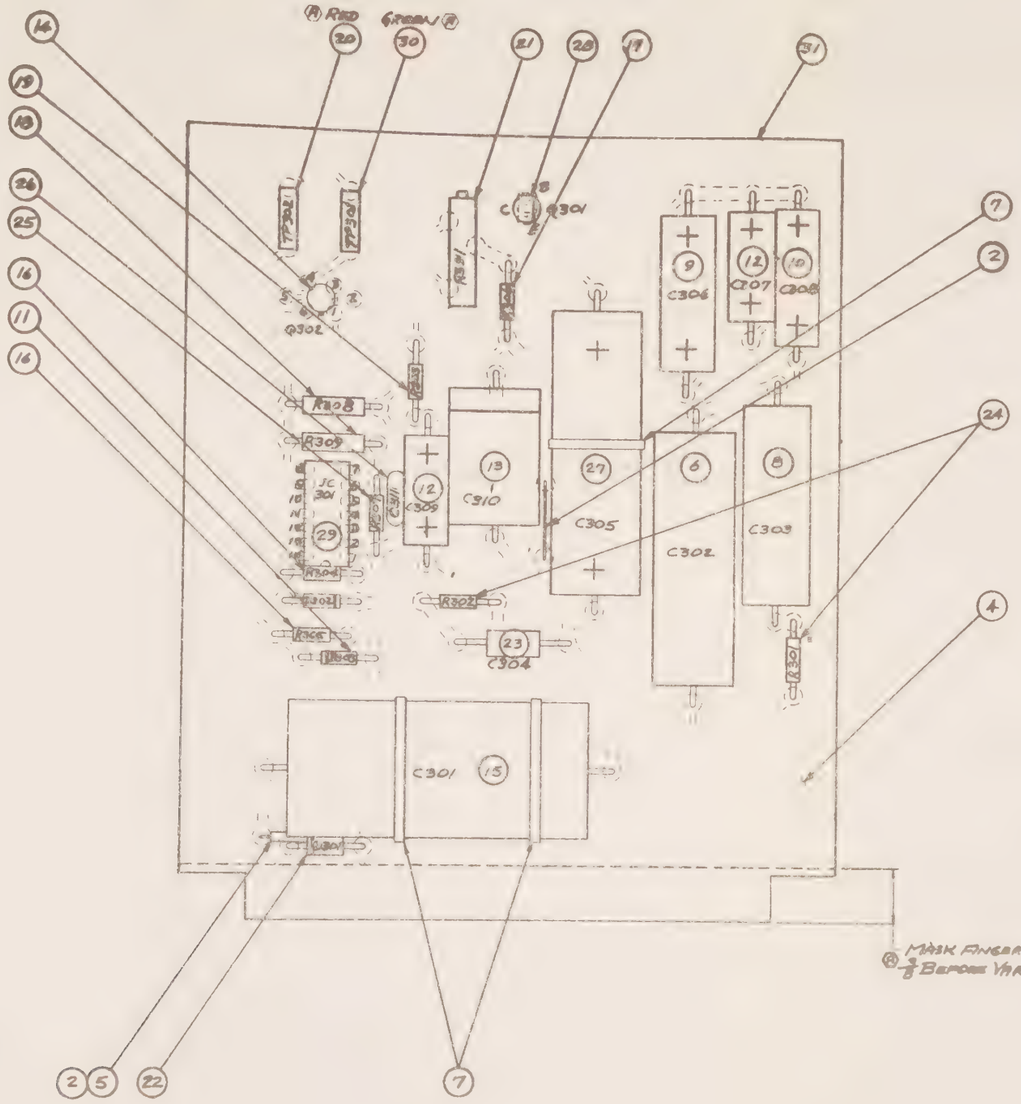
(D) 2. FOR SCHEMATIC SEE DWG. D6-6233
(C) 1. APPLY VARNISH, ITEM #4, TO BOTH SIDES OF BOARD AFTER ELECTRICAL CHECK.
NOTE:

Figure A-17 Digital Sweep Frequency Limit PC Board

LTR.	REVISION	CHANGE ORDER	CK'D DATE	APP'D DATE
A	ADDED MTG. DETAIL & NOTES	~	LATHROP 3-28-74	
B	ITEM "7 W32" & REQD.	1269	LATHROP 3-6-74	
C	ADDED N.P. DESIG TO IT 9 & 10	~	LATHROP 3-26-74	
D	ADDED COMPONENT DESIG. NO. & NOTE "2	—	LATHROP 5-28-74	



(A) MASK FINGERS APPROX. 3/8 BEFORE VARNISHING.

(A) MTG. DETAIL FOR ITEMS #14 & 28

(A) 2. FOR SCHEMATIC SEE DWG. D6-6233.
(B) 1. APPLY VARNISH, ITEM #4, TO BOTH SIDES OF BOARD AFTER ELECTRICAL CHECK.
NOTES:

ITEM NO.	PART NO.	NO. REQ.	DRAWING NO	DESCRIPTION / SPECIFICATION	MODEL	NEXT ASSEMBLY	NO. REQ.
31	10006	1	C4-5487	BOARD, 1ST SAWTOOTH MV-FF			
30	9942	1		JACK, GREEN TIP			
29	9931	1		SEMICOND, MC-1709-CL			
28	9919	1		SEMICOND, 2N5306			
27	9917	1		CAPACITOR, 1100 MF 3V			
26	9880	1		CAPACITOR, 24 PF			
25	9860	1		RESISTOR, 3.92K 1/8W 1%			
24	9478	2		RESISTOR, 6.81 OHM 1/8W 1%			
23	9336	1		CAPACITOR, .033 MF 80V 5%			
22	9217	1		SEMICOND, 1N5283			
21	8337	1		POT, 5K			
20	7886	1		JACK, RED TIP			
19	7877	1		RESISTOR, 10M 1/4W 5%			
18	7872	2		RESISTOR, 562K 1/8W 1%			
17	7869	1		RESISTOR, 150K 1/8W 1%			
16	7859	2		RESISTOR, 10K 1/8W 1%			
15	7839	1		CAPACITOR, 10MF 200V			
14	7828	1		SEMICOND, GK101			
13	6627	1		CAPACITOR, 2MF 50V 10%			
12	5464	2		CAPACITOR, 25MF 12V			
11	5399	2		SEMICOND, 1N5231B			
(C) 10	5029	1		CAPACITOR, 5MF 25V NP			
(C) 9	5023	1		CAPACITOR, 250MF 3V NP			
8	4985	1		CAPACITOR, .33 MF 100V 1%			
(B) 7	4406	3		TIES, SELF CLINCHING			
6	3500	1		CAPACITOR, 3 MF 50V 1%			
5	3398	AR		SPAGHETTI, 24 GA			
4	2878	AR		VARNISH			
3	2365	AR		SOLDER, 60/40			
2	2363	AR		WIRE, #22 BARE TINNED COPPER			
1	9603	1		BOARD, 1ST SAWTOOTH PC ASM	360	D2-4851	1

TOLERANCES UNLESS SPECIFIED OTHERWISE
FRACTIONS: ± 1/64" DECIMALS: ± 0.005" ANGLES: ± 1/2°

DRAWN BY	CHECKED BY	APPROVED BY	APPROVED BY	SCALE
[illegible]	Y.S. 7-20 1973	[illegible]	[illegible] 18-APR-74	REF. ONLY
D-25 1973				2 × SIZE

TITLE: BOARD-1ST SAWTOOTH MV-FF PC ASM

IRD MECHANALYSIS, INC.
COLUMBUS, OHIO

DRAWING NUMBER: D2-5631

SHEET 1 OF 1

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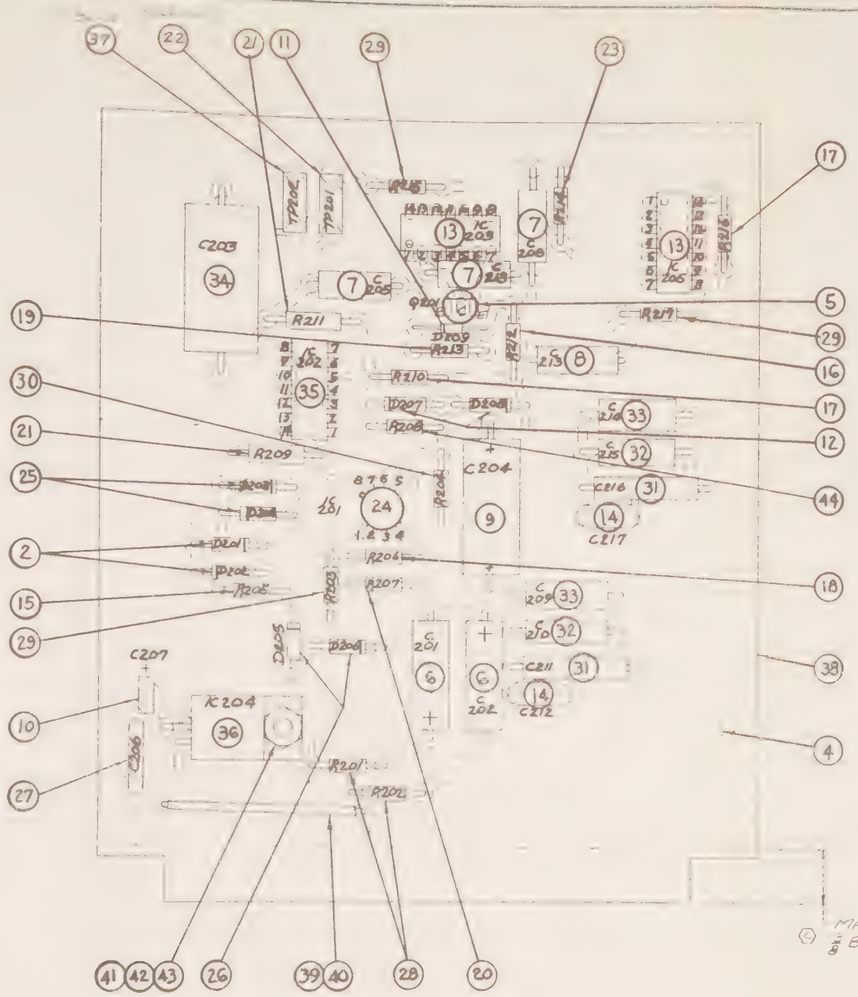
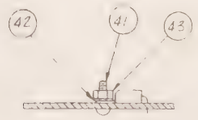
Figure A-18 No. Sawtooth MV-FF PC Board



(C) MASK FINGERS APPROX. $\frac{5}{8}$ BEFORE VARNISHING



(D) MTG DETAIL FOR ITEM #36

(E) MTG. DETAIL FOR ITEM #5

(D) 2. FOR SCHEMATIC SEE DWG. D6-6233
1. APPLY VARNISH, ITEM #4, TO BOTH SIDES OF BOARD
(D) AFTER ELECTRICAL CHECK.
NOTE:

ITR	REVISIONS	CHANGE	
A	REVISED ROUTING OF ITEM 32 & 40 & REPLACED ITEMS 41 & 43 WITH NYLON	~	3-5-74
B	ITEM 27 BALLOON NOS 22	~	
C	ADDED MTG. DETAIL & NOTES	~	3-5-74
D	ADDED COMPONENT DESIG NO. & NOTE #2. (2)	—	5-28-74
E	ITEM 17 & 24, ITEM 24 WAS MFR BECK SEMICONL 794 MINI DIP ITEM 5 WAS 2 REQD, ITEM 9 WAS FAN 5089 344 IMS 200V 20%	8226	6-4-77 6-7-77
F	ADDED FIND NOS 45 & 46 FIND NO 39 WAS AR REQD.	2635	5-18-77 6-15-77

ITEM NO.	PART NO.	NO REQ.	DRAWING NO.	DESCRIPTION / SPECIFICATION
(F)	46	90462	-		QCI 2-36 REFERENCE INPUT PCB ASM
F	45	90969	-	D6-6233	SCHEMATIC
F	44	7943	1		RES/STOR, 1K 1/8W 1%
	43	9510	1		NUT #4-40 NYLON
	42	19	1		WASHER, #4 I.S. LOCK
	41		1		SCREW, 4-40 SLOT HEAD NYLON x 3/8 LG.
	40		AR		SPAGHETTI 24GA.
(F)	39		151		WIRE, #22 BARE TINNED COPPER
	38		1	4-5477	BOARD PC
	37	7943	1		TEST JACK BLUE
	36	9510	1		SEMICOND UA 7805-393
	35	9511	1		SEMICOND MC-1709 CL
	34	9203	1		CAPACITOR 3MF-50V 5%
	33	9223	2		CAPACITOR .1MF-50V 5%
	32	9221	2		CAPACITOR .01MF-50V 5%
	31	9983	2		CAPACITOR .001MF-50V 5%
	30	3875	1		RESISTOR 4.7M 1/4W 5%
	29	9253	3		RESISTOR 2.74K 1/8W 1%
	28	3856	2		RESISTOR 1.82K 1/8W 1%
	27	9210	1		CAPACITOR .1MF-16V CERAMIC
	26	9218	2		SEMICOND 1N5270
	25	9217	2		SEMICOND 1N5283
(E)	24	14993	1		SEMICOND CA3140AS
	23	8265	1		RESISTOR 12.7K 1/8W 1%
	22	7887	1		TEST JACK YELLOW
	21	7872	2		RESISTOR 562K 1/8W 1%
	20	7866	1		RESISTOR 47.5K 1/8W 1%
	19	7863	1		RESISTOR 22.1K 1/8W 1%
	18	7859	1		RESISTOR 10K 1/8W 1%
	17	7857	2		RESISTOR 6.81K 1/8W 1%
	16	7856	1		RESISTOR 4.75K 1/8W 1%
(E)	15	7843	1		RESISTOR 100 OHM 1/8W 1%
	14	7837	2		CAPACITOR 100 PF
	13	7829	2		SEMICOND MC3601P
	12	5309	3		SEMICOND IN5231B
	11	5399	1		SEMICOND IN914
	10	5394	1		CAPACITOR .33MF-50V TANTALUM
(E)	9	5015	1		CAPACITOR 5MF-25V NP
	8	5040	1		CAPACITOR .01MF-200V
	7	5038	3		CAPACITOR .0047MF-200V
	6	5026	2		CAPACITOR 10MF-25V
	5	4826	1		SEMICOND 2N3391
	4	2878	AR		VARNISH
	3	2365	AR		SOLDER 60/40
	2	1380	2		SEMICOND 1N67A
	1	9602			BOARD PC ASM BD. #2	360	D2-4851	1

TOLERANCES UNLESS SPECIFIED OTHERWISE
FRACTIONS ± 1/64" DECIMALS ± 0.005" ANGLES ± 1/2°

DRAWN BY K. BOXELL | CHECKED BY | APPROVED BY | APPROVED BY | SCALE REF. ONLY

TITLE: BOARD-REFERENCE INPUT PC ASM.

IRD MECHANALYSIS, INC.
COLUMBUS, OHIO

DRAWING NUMBER D2-5632 | F | SHEET 1 OF 1

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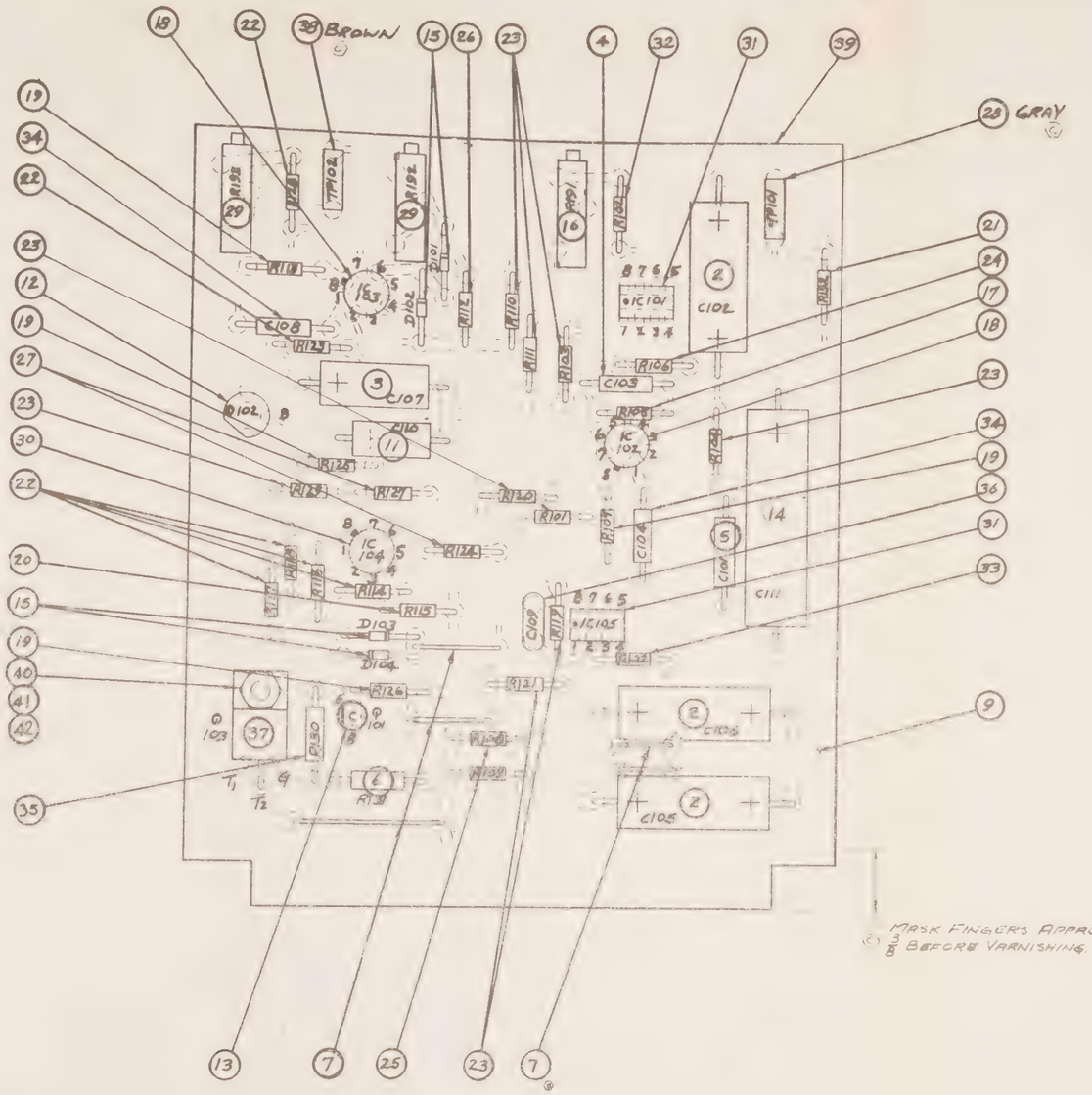
Figure A-19 Reference Input PC Board


BROWN
GRAY
MASK FINGERS APPROX 3/8 BEFORE VARNISHING.
MTG. DETAIL FOR ITEM #35.
MTG. DETAIL FOR ITEM #37
MTG. DETAIL FOR ITEMS #12,13,18 #30
2. FOR SCHEMATIC SEE DWG. D6-6233
1. APPLY VARNISH, ITEM #9, TO BOTH SIDES OF BOARD AFTER ELECTRICAL CHECK.
NOTE:

LTR	REVISION	CHANGE ORDER	CK'D DATE	APP'D DATE
A	ADDED ITEMS 1041 2	~		
B	ADDED TAB [illegible] 50	~		
C	ADDED MFR DETAILS NOTES 1 & 2	—		
D	ITEM 34 WAS 100V 10%	~		
E	ADDED [illegible]	—		
F	IT. 43 WAS 5027 25MF 25V 10DMCL 12V ADLED P/N 3605	2085		
G	ADDED FIND # 43 & 44 FIND 7 WAS AR REQ'D	2635		

ITEM NO.	PART NO.	NO. REQ.	DRAWING NO.	DESCRIPTION / SPECIFICATION	MODEL	NEXT ASSEMBLY	NO. REQ.
44	9046	1		GC1-2-35 SIGNAL PREAMP PCB			
G 43	9096	1	D6-6233	SCHEMATIC			
42	1907	1		WASHER #4 I.S. LOCK			
41	9570	1		NUT #4-40 NYLON			
40	9569	1		SCREW #4-40 X 3/8" SLOT HEAD NYLON			
39	10004	1	C1-5457	BOARD, SIGNAL PREAMP PC.			
38	9940	1		JACK, BROWN TIP			
37	9922	1		SEMICOND, #40668			
36	9880	1		CAPACITOR, 24 PF			
35	9878	1		RESISTOR 470 OHM 1/2 W 5%			
D 34	9308	2		CAPACITOR, .0022 MF 50V 5%			
33	9305	1		RESISTOR, 22 M 1/4 W 5%			
32	9273	1		RESISTOR, 32.4 K 1/8 W 1%			
31	8595	2		SEMICOND, 741 MINI DIP			
30	8554	1		SEMICOND, MC 1458			
29	8337	2		POT, 5K			
28	7888	1		JACK, GRAY TIP			
27	7870	2		RESISTOR, 332 K 1/8 W 1%			
26	7869	1		RESISTOR, 100K 1/8 W 1%			
25	7866	2		RESISTOR, 47.5K 1/8 W 1%			
24	7860	1		RESISTOR, 15K 1/8 W 1%			
23	7859	9		RESISTOR, 10K 1/8 W 1%			
22	7857	6		RESISTOR, 6.81K 1/8 W 1%			
21	7856	1		RESISTOR, 4.75K 1/8 W 1%			
20	7854	1		RESISTOR, 3.32K 1/8 W 1%			
19	7848	4		RESISTOR, 1K 1/8 W 1%			
18	7827	2		SEMICOND, MC 1439 G			
17	7687	1		RESISTOR, 78.7K 1/8 W 1%			
16	8476	1		POT, 20K			
15	5398	4		SEMICOND, IN 914			
14	5323	1		CAPACITOR, 500 MF 15V			
13	4026	1		SEMICOND, 2N 3391			
12	4583	1		SEMICOND, 2N 3568			
11	3537	1		CAPACITOR, 5 MF 25V			
C 10							
9	2878	AR		VARNISH			
8	2365	AR		SOLDER, 60/40			
G 7	2363	1 ft		WIRE, #22 BARE TINNED COPPER			
6	1586	1		RESISTOR, 470 OHM 1W 5%			
5	1471	1		CAPACITOR, 51 PF 500V 5%			
4	5195	1		CAPACITOR, 33 PF 500V 5%			
F 3	3605	1		CAPACITOR, 100 MFD 12V			
2	5023	3		CAPACITOR, 250 MF 3V			
1	9401			BOARD, SIGNAL PREAMP PC ASM.	360	D2-4051	1

TOLERANCES UNLESS SPECIFIED OTHERWISE
FRACTIONS: ± 1/64" DECIMALS: ± 0.005" ANGLES: ± 1/2°

DRAWN BY [illegible] 6-21 1973 | CHECKED BY [illegible] 7-24 1973 | APPROVED BY [illegible] 10-1 1974 | APPROVED BY: [illegible] | SCALE: NSS ONLY

TITLE: BOARD-SIGNAL PREAMP. P.C. ASM.

IRD MECHANALYSIS, INC. COLUMBUS, OHIO

DRAWING NUMBER D2-5628 G | SHEET 1 of 1

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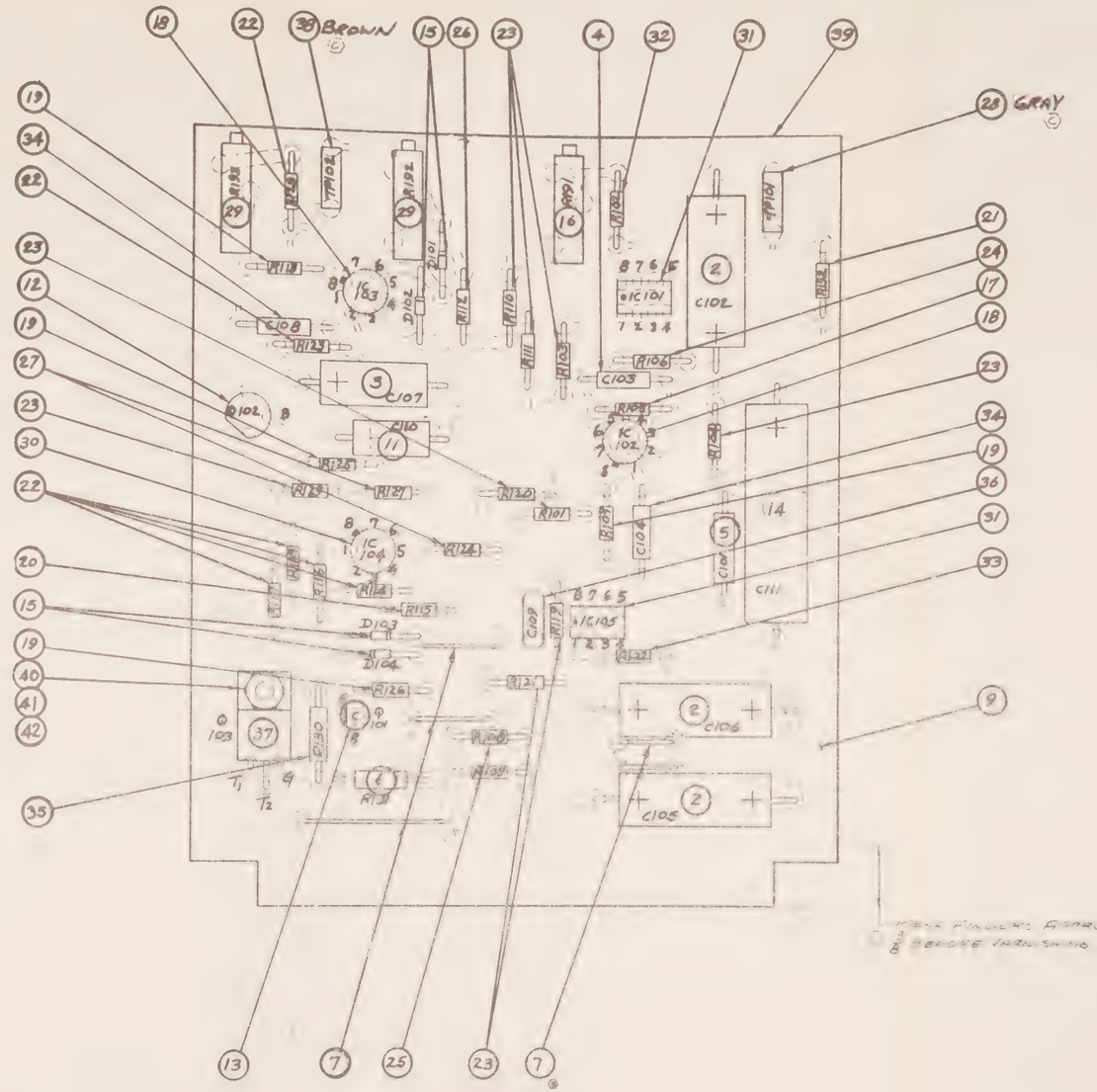
Figure A-20 Signal Preamplifier PC Board


BROWN
GRAY
R102
C108
C107
C110
IC 102
IC 104
C102
C104
C111
14
IC 101
IC 105
C106
C105
R103
R104
R105
R106
R107
R108
R109
R110
R111
R112
R113
R114
R115
R116
R117
R118
R119
R120
R121
R122
R123
R124
R125
R126
R127
R128
R129
R130
D101
D102
D103
D104
D 103
Q 101
Q 102
T1
T2
C103
C109
C101
R101
R102
R131
R132
R133
R134
R135
R136
R137
R138
R139
R140
R141
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R143
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R162
R163
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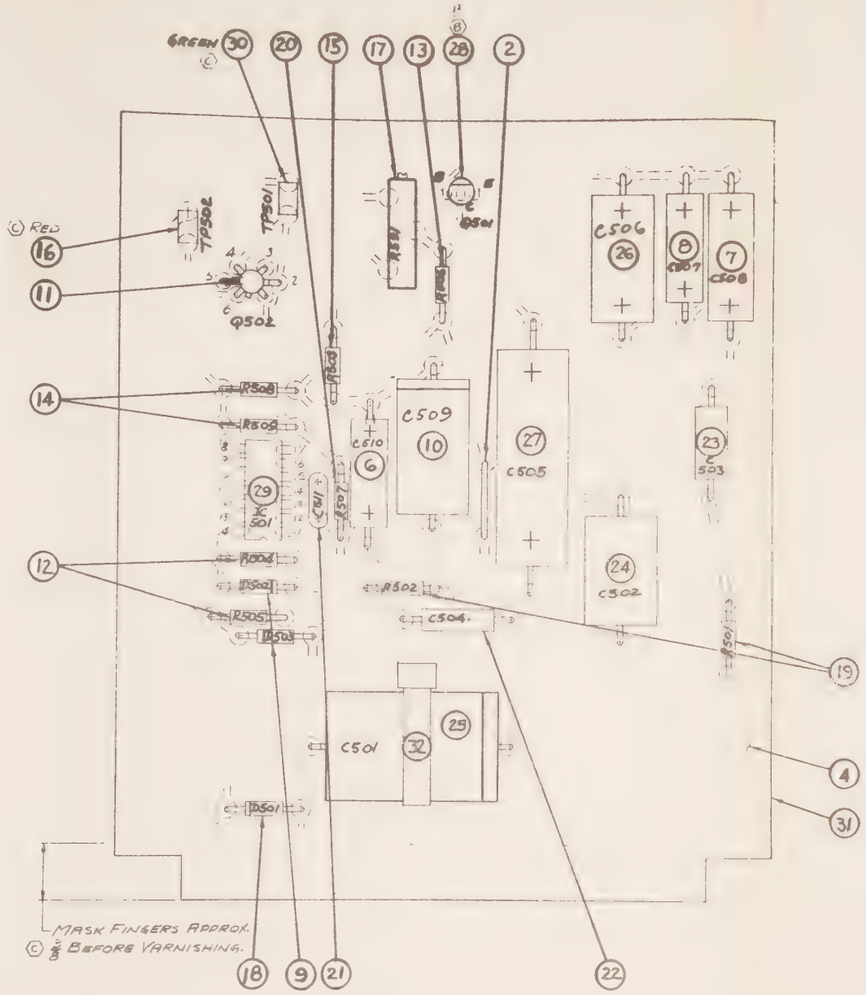
R165
R166
R167
R168
R169
R170



(C) MTG DETAIL FOR ITEMS 11 28

(D) 2. FOR SCHEMATIC SEE DWG D6-6233

(E) APPLY VARNISH, ITEM #4, TO BOTH SIDES OF BOARD AFTER ELECTRICAL CHECK.

NOTE:

LTR	REVISION	CHANGE ORDER	CK'D DATE	APP'D DATE
A	REVISED TO CONFORM TO DRILLING DWG [6]	—	10-13-73	
B	REVISED ITEM 22 CIRCUIT PATHS [27]	~	10-19-73	
C	ADDED MTG. DETAIL & NOTES 3 THRU 5 [27]	~	3-5-74	
D	ADDED ASSEMBLY DRG. NO. & NOTE #4 [27]	—	9-26-74	
E	ADDED FIND NOS. 33 + 34 FIND NO. 2 WAS AR REQD [28]	2635	5-15-77	

ITEM NO	PART NO.	NO. REQ.	DRAWING NO.	DESCRIPTION / SPECIFICATION	MODEL	NEXT ASSEMBLY
(E) 34	90465	—		QCI 2-29 2ND SAWTOOTH PCB ASM		
(E) 33	90969	—	D6-6233	SCHEMATIC		
32	4406	1		TIE SELF-CLINCHING		
31	10008	1	C4-5543	BOARD, PC		
30	9942	1		TEST JACK, GREEN		
29	9931	1		SEMICOND, MC-1709CL		
28	9919	1		SEMICOND, 2N5306		
27	9916	1		CAPACITOR, 600MF-3V NP		
26	9915	1		CAPACITOR, 100MF-6V NP		
25	9910	1		CAPACITOR, 5MF-100V 10%		
24	9907	1		CAPACITOR, 1.5 MF-50V 1%		
23	9894	1		CAPACITOR, .15 MF-50V 1%		
22	9809	1		CAPACITOR, .015 MF-50V 5%		
21	9880	1		CAPACITOR, 24 PF		
20	9860	1		RESISTOR, 3.92K ⅛W 1%		
19	9478	2		RESISTOR, 6.81 OHM ⅛W 1%		
18	9217	1		SEMICOND, 1N3283		
17	8337	1		POT. 5K		
16	7886	1		TEST JACK, RED		
15	7877	1		RESISTOR, 10M ¼W 5%		
14	7872	2		RESISTOR, 562K ⅛W 1%		
13	7869	1		RESISTOR, 130K ⅛W 1%		
12	7859	2		RESISTOR, 10K ⅛W 1%		
11	7828	1		SEMICOND, GK101		
10	5627	1		CAPACITOR, 2MF-50V 10%		
9	5399	2		SEMICOND, 1N5231B		
8	5118	1		CAPACITOR, 10MF-6V NP		
7	5029	1		CAPACITOR, 5MF-25V NP		
6	3668	1		CAPACITOR, 28MF-6V NP		
5						
4	2878	AR		VARNISH		
3	2365	AR		SOLDER 60/40		
(E) 2	2363	DET		BARE WIRE		
1	9605	1		BOARD, PC ASM Rev 5	360	D2-4851

TOLERANCES UNLESS SPECIFIED OTHERWISE: FRACTIONS ± 1/64" DECIMALS ± 0.005" ANGLES: ± 1/2°

DRAWN BY: [illegible] 6-27-1973 CHECKED BY: [illegible] APPROVED BY: [illegible] 10-4-1974 SCALE: REF. ONLY 2 X

TITLE: BOARD, 2ND SAWTOOTH, MV-FF PC ASM.

IRD MECHANALYSIS, INC. COLUMBUS, OHIO

DRAWING NUMBER D2-5637. E SHEET 1 of 1

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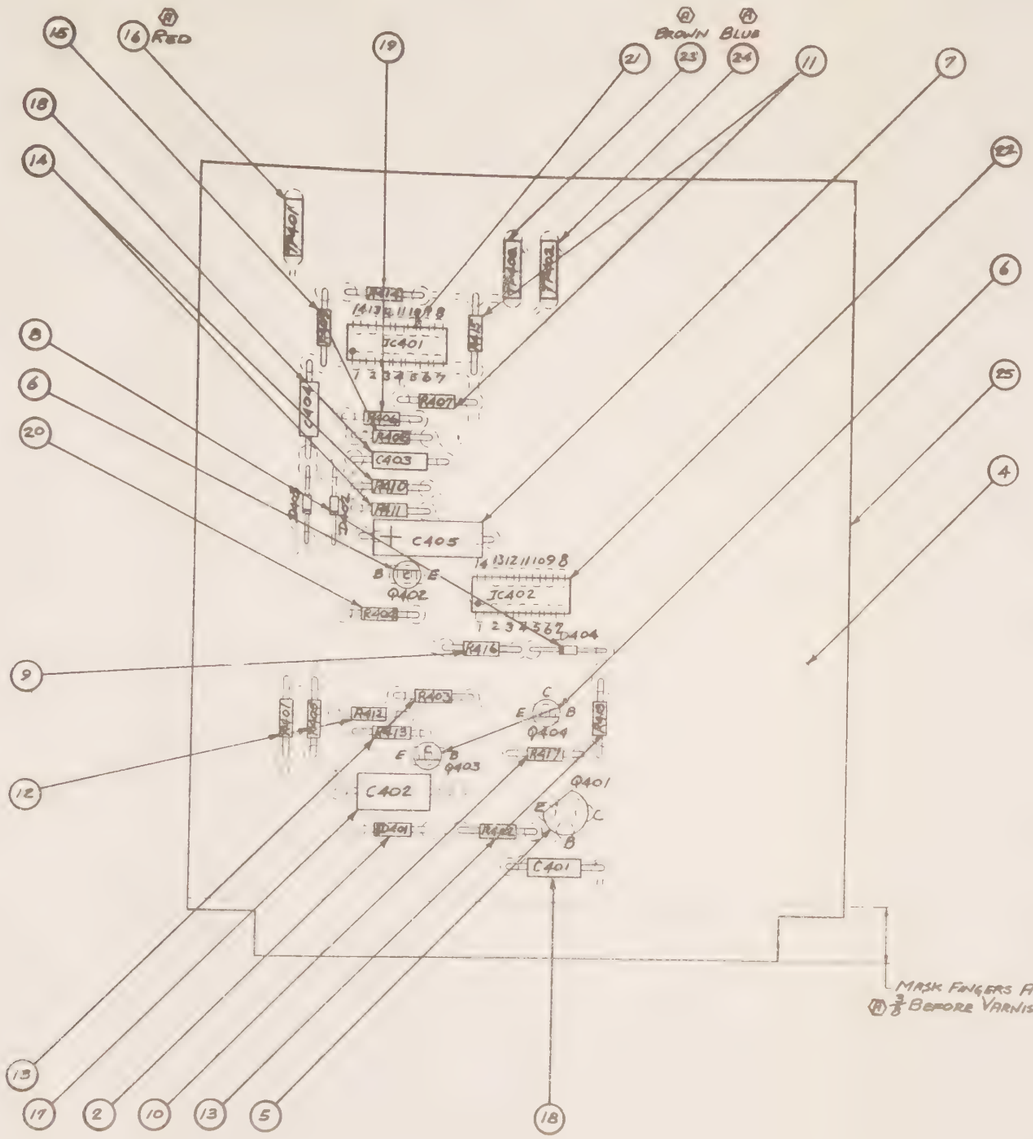
Figure A-21 No. 2 Sawtooth MF-FF PC Board

LTR	REVISION	CHANGE ORDER	APP'D DATE	APP'D
A	ADDED MTG. DETAIL & NOTES	~	3-2-73	
B	ADDED UNIVERSAL DESIGN NO. & NOTE #2.	—	LARRY 5-28-73	



ITEM NO.	PART NO.	NO. REQ.	DRAWING NO.	DESCRIPTION / SPECIFICATION	MODEL	NEXT ASSEMBLY	NO. REQ.
25	10007	1	C4-5488	BOARD, ERROR GATE PULSE DOUBLER P.C.			
24	9943	1		JACK, BLUE TIP			
23	9940	1		JACK, BROWN TIP			
22	9930	1		SEMICOND, MC-672P			
21	9928	1		SEMICOND, MC-663P			
20	9860	1		RESISTOR, 3.92K 1/8 W 1%			
19	9645	2		RESISTOR, 825 OHM 1/8 W 1%			
18	9632	3		CAPACITOR, .001 MF 80V 10%			
17	9342	1		CAPACITOR, .1 MF 80V 10%			
16	7886	1		JACK, RED TIP			
15	7866	2		RESISTOR, 47.5K 1/8 W 1%			
14	7863	2		RESISTOR, 22.1K 1/8 W 1%			
13	7859	4		RESISTOR, 10K 1/8 W 1%			
12	7857	3		RESISTOR, 6.81K 1/8 W 1%			
11	7854	2		RESISTOR, 3.32K 1/8 W 1%			
10	7852	1		RESISTOR, 2.21K 1/8 W 1%			
9	7848	1		RESISTOR, 1K 1/8 W 1%			
8	5398	3		SEMICOND, IN 914			
7	5027	1		CAPACITOR, 25MF 25V			
6	4826	3		SEMICOND, 2N3391			
5	4586	1		SEMICOND, 2N3638			
4	2878	AR		VARNISH			
3	2365	AR		SOLDER, 60/40			
2	1380	1		SEMICOND, IN 67A			
1	9604			BOARD, ERROR GATE PC ASM	360	D2-4851	1

TOLERANCES UNLESS SPECIFIED OTHERWISE: FRACTIONS ± 1/64" DECIMALS ± 0.005" ANGLES ± 1/2°

DRAWN BY: [illegible] 1-9 1973 | CHECKED BY: [illegible] 1-9 1973 | APPROVED BY: [illegible] 1-11-73 | APPROVED BY: [illegible] 7/13/73 | SCALE: REF. ONLY | LK Sizer

TITLE: BOARD-ERROR GATE PULSE DOUBLER DIVIDE 2 JK-FF PC. ASM.

IRD MECHANALYSIS, INC. COLUMBUS, OHIO

DRAWING NUMBER D2-5652 | SHEET 1 OF 1

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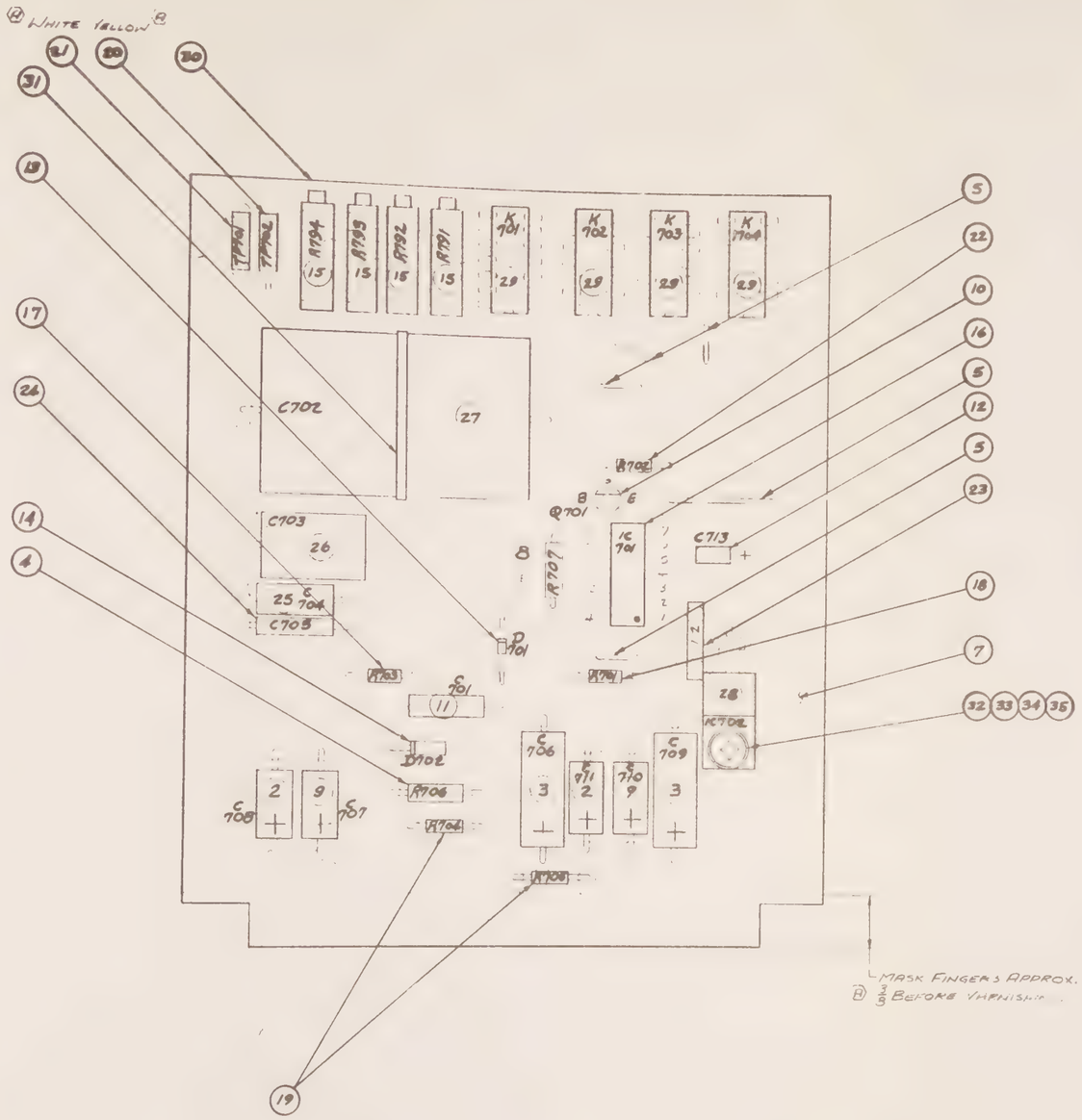
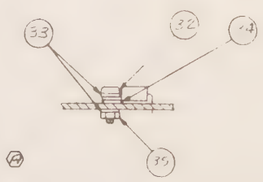
(B) 2. FOR SCHEMATIC SEE DWG. D6-6233

(A) 1. APPLY VARNISH, ITEM #4, TO BOTH SIDES OF BOARD AFTER ELECTRICAL CHECK.

NOTE:

Figure A-22 Error Gate Pulse Doubler Divide, 2 JK-FF PC Board





THIS DWG TO BE USED FOR UNITS PREFIX "D" ONLY

(C) 2. FOR SCHEMATIC SEE DWG. D6-6233
(A) 1. APPLY VARNISH, ITEM #7, TO BOTH SIDES OF BOARD AFTER ELECTRICAL CHECK.
NOTES:

LTR	REVISION	CHANGE ORDER	CK'D DATE	APP'D DATE
A	ADDED MTG. DETAILS & NOTES DELETED ITEM 3 SPACE ITI	~	NWL 3-5-74	
B	CHANGED ITEMS 32,33,35 TO BLACK PENETRATE FINISHED PARTS WERE P/N 1871 & P/N 4763	~	NWL 3-26-74	
C	ADDED COMPONENT LOCTS. NO. & NOTE "2" [1]	—	ARTWORK 5-25-74	
D	ITEM 11 WAS P/N 5040,-01 MF. [2]	1618	5-8-75	
E	ADDED: 172 IN #, ITEM 11 WAS P/N 5042, .022MF 200K	2226	4-6-77	
F	ADDED FIND NOS. 36 & 37 FIND NO. 3 WAS AR REQ'D [3]	2635	5-18-77	

ITEM NO	PART NO.	NO. REQ.	DRAWING NO.	DESCRIPTION / SPECIFICATION
F	37	90467	-		OCI 2-41 FREQ. TO D.C. CONVERTER PCB ASM.
E	36	90969	-	D6-6233	SCHEMATIC
B	35	9565	1		NUT, #4-40 BLACK PENETRATE
	34	1869	1		WASHER, #4 PLAIN
	33	1927	2		WASHER #4 I.S. LOCK
B	32	5541	1		SCREW, #4-40 x 3/8 PPHM BLACK PENETRATE
	31	4406	1		TIE, SELF CLINCHING
	30	17012	1	24-5544	BOARD, FREQ TO DC CONVERTER
	29	9945	4		RELAY, 5V DC 2 FORM A 3VA CONTACT
	28	9916	1		SEMICOND, LM-7805-393
	27	9912	1		CAPACITOR, 15MF 100V 20%
	26	9907	1		CAPACITOR 1.5MF 50V 1%
	25	9874	1		CAPACITOR .15 MF 50V 1%
	24	9320	1		CAPACITOR .215MF 50V 1%
	23	9910	1		CAPACITOR, .1 MF 16 V CERAMIC
	22	9284	1		RESISTOR 21K 1/8W 1%
	21	7889	1		JACK, WHITE TEST
	20	7887	1		JACK YELLOW TEST
	19	7863	2		RESISTOR, 22.1K 1/8 W 1%
	18	7859	1		RESISTOR, 10K 1/8 W 1%
	17	7857	1		RESISTOR, 6.81K 1/8W 1%
	16	7829	1		SEMICOND, MC-8601P
	15	5579	4		POT, 10K
	14	5399	1		SEMICOND, IN5231B
	13	5398	1		SEMICOND, IN914
	12	5394	1		CAPACITOR, .33MF 50V TANTALUM
E D	11	9336	1		CAPACITOR, .033 MF 80V
	10	4826	1		SEMICOND, 2N3391
	9	3597	2		CAPACITOR, 5MF 25V
E	8	7950	1		RESISTOR, 2K 1/8 W 1%
	7	2878	AR		VARNISH
	6	2365	AR		SOLDER, 60/40
F	5	2363	2FT		WIRE, #22 BARE TINNED COPPER
	4	1584	1		RESISTOR, 100 OHM MW 5%
	3	1481	2		CAPACITOR, 50 MF 25V
	2	1473	2		CAPACITOR, 1 MF 50V 10%
	1	9607			BOARD, FREQ TO DC CONV. ASM

NEXT ASSEMBLY	360	D2-4851	F

TOLERANCES UNLESS SPECIFIED OTHERWISE
FRACTIONS ± 1/64" DECIMALS ± 0.005" ANGLES ± 1/2°

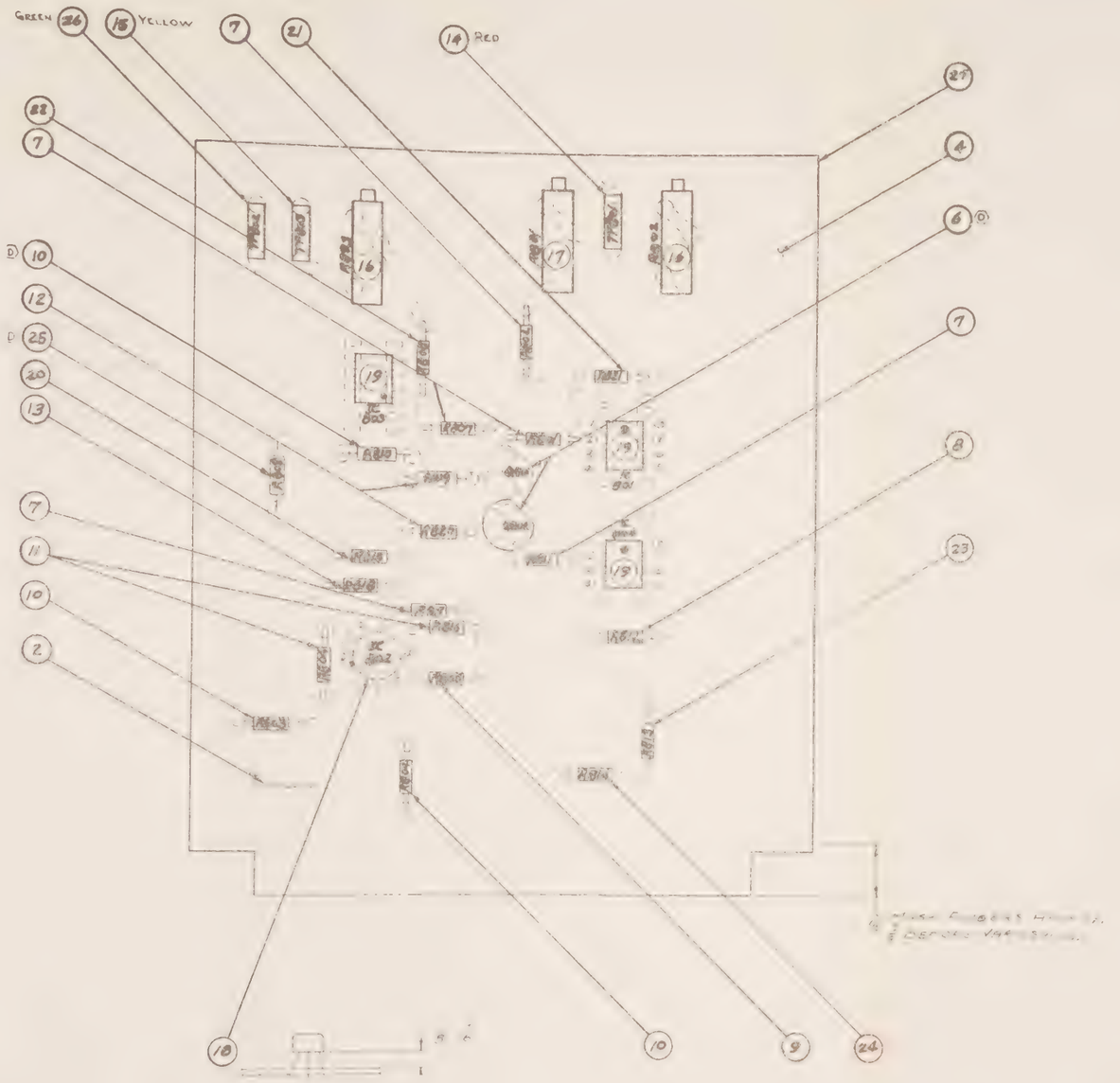
DRAWN BY	CHECKED BY	APPROVED BY	APPROVED BY	SCALE
[illegible] 7-11-1973	[illegible] 7-20-1973	[illegible]	[illegible]	AR, ONLY

TITLE: BOARD-FREQ. TO D.C. CONVERTER ASM.

IRD MECHANALYSIS, INC.
COLUMBUS, OHIO

DRAWING NUMBER D2-5663 F

Figure A-23 Frequency to DC Converter PC Board



LTR.	REVISION	CHANGE ORDER	CK'D DATE	APP'D DATE
A	ADDED MTG DETAIL AND NOTES 10 DELETED ITEMS 3 & 11	~	[illegible] 3-5-79	[illegible] 3-19-79
B	DELETED ITEM 25 & ADDED JUMPER. DELETED ITEM 10 & ADDED NOTE	1298	[illegible] 3-19-79	[illegible] 3-19-79
C	ADDED COMPONENT DESIG. NO. & NOTE #2.	—	[illegible] 5-28-79	[illegible] 6-4-79
D	ITEM 6 P/N WAS 4826. ITEM 10 NO REQ. WAS 2. ITEM 25 ADDED.	2554	[illegible] 5-7-7-	[illegible] 5-17-77
E	ADDED END # 28-29 FIND 2 WAS AR REQD	2635	[illegible] 6-16-77	[illegible] 6-30-77

ITEM NO	PART NO.	NO. REQ.	DRAWING NO.	DESCRIPTION / SPECIFICATION	MODEL	NEXT ASSEMBLY	NO. REQ.
29	90468			QC1-2-42 DC AMP & RECORDER OUTPUT AMP PCB			
28	90969	-	D6-6233	SCHEMATIC			
27	10011		D4-5570	BOARD, DC AMP & RECORDER OUTPUT PC.			
26	9942	1		JACK, GREEN TEST			
D 25	9906	1		RESISTOR, 51.1 OHM 1/8 W 1%			
24	9979	1		RESISTOR 1.5M 1/4 W 5%			
23	9908	1		RESISTOR, 24.3K 1/8 W 1%			
22	9939	1		RESISTOR 274 OHM 1/8 W 1%			
21	9926	1		RESISTOR, 221K 1/8 W 1%			
20	8674	1		RESISTOR 287K 1/8 W 1%			
19	8555	5		SEMICOND. TL 071 MIN-DIP			
18	8554	1		SEMICOND. MC-1458			
17	8837	1		POT 5K			
16	8836	2		POT 1K			
15	7947	1		JACK YELLOW TEST			
14	7946	1		JACK RED TEST			
13	7870	1		RESISTOR 392K 1/8 W 1%			
12	7963	2		RESISTOR 26.1K 1/8 W 1%			
11	7960	2		RESISTOR 15K 1/8 W 1%			
D 8 10	7859	3		RESISTOR 10K 1/8 W 1%			
9	7856	1		RESISTOR 4.75K 1/8 W 1%			
8	7852	1		RESISTOR 2.21K 1/8 W 1%			
7	7818	5		RESISTOR, 1K 1/8 W 1%			
D 6	4563	2		SEMICOND. 2N3568			
5							
4	1978	AR		VARNISH			
3	1365	AR		SOLDER 60/40			
E 2	1369	6 FT		WIRE #22 GA. BARE TINNED COPPER			
1	9608			BOARD, DC AMP & RECORDER OUTPUT	360	02-4851	1

TOLERANCES UNLESS SPECIFIED OTHERWISE: FRACTIONS ± 1/64" DECIMALS ± 0.005" ANGLES ± 1/2°

DRAWN BY [illegible] 7-10-197[illegible] CHECKED BY [illegible] 10-[illegible]-197[illegible] APPROVED BY [illegible] APPROVED BY [illegible] 11-[illegible]-197[illegible] SCALE REF. ONLY 2X SIZE

TITLE: BOARD-DC AMP & RECORDER OUTPUT, AMP. METER CIRCUIT P.C. ASM.

IRD MECHANALYSIS, INC. COLUMBUS, OHIO

DRAWING NUMBER D8-5677 E SHEET 1 OF 1

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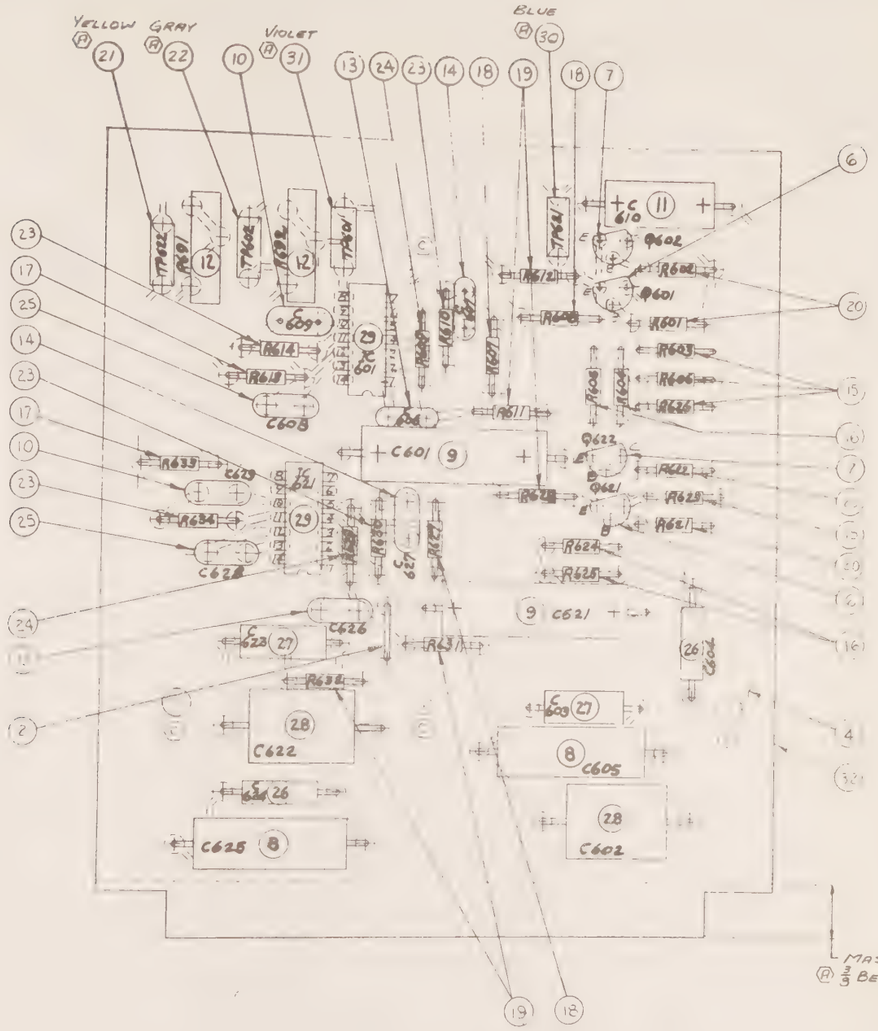
(C) 2. FOR SCHEMATIC SEE DWG D6-6233

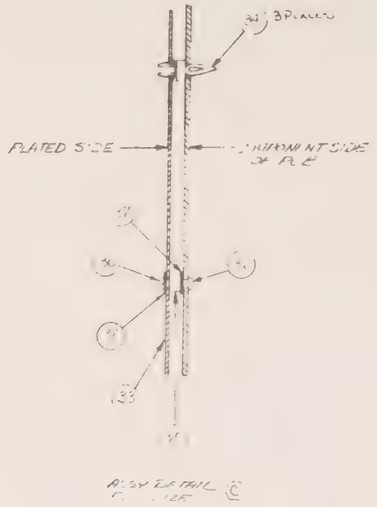
(B) 1. APPLY VARNISH, ITEM #4, TO BOTH SIDES OF BOARD AFTER ELECTRICAL CHECK.

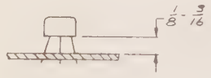
NOTE:

Figure A-24 DC Amp. and Rec. Output, Amp. Meter-Circuit PC Board

LTR	REVISION	CHANGE ORDER	C.K'D DATE	APP'D DATE
A	ADDED MTG. DETAIL & NOTES 12 & 13. ALL ITEM 2 SHOWN	—	NWL 3-5-76	
B	ADDED COMPONENT DESIG. NO. & NOTE "2" (2)	—	[illegible] 3-26-76	
C	ADDED DETAIL, ITEMS 33 THRU 37 & NOTES 4 PLACES.	2226	[illegible] 4-6-77	[illegible] 4-7-77
D	ADDED FIND NOS. 38 & 39 FIND NO. 2 WAS AR REQ'D IN	2635	[illegible] 5-18-77	[illegible] 6-20-77







ITEM NO.	PART NO.	NO. REQ.	DRAWING NO.	DESCRIPTION / SPECIFICATION
D	39	90466	-		QCI 2-40 ELECTRONIC SWITCH & INTEGRATOR PCB
D	38	90969	-	D6 6233	SCHEMATIC
C	37	[illegible]	2		WASHER, #4 INTERNAL STAR LOCK
	36	[illegible]	2		SCREW, #4-40 X 3/16 SLOTTED ROUND HEAD
	35	[illegible]	2		SPACER, 1/4 OD. X .171 I.D. X 1/4 LG. ALUMINUM
	34	[illegible]	3		SUPPORT, NYLON #CB5-3N
	33	[illegible]	1	B4-5[illegible]	SHIELD
	32	[illegible]	1	C4-5541	BOARD, PC
	31	9944	1		TEST JACK, VIOLET
	30	9943	1		TEST JACK, BLUE
	29	9912	2		SEMICOND., MC-1437-L
	28	9907	2		CAPACITOR, 1.5MF - 50V 1%
	27	9894	2		CAPACITOR, .15MF-50V 1%
	26	9888	2		CAPACITOR, .015MF-50V 1%
	25	9860	2		CAPACITOR, 24PF
	24	9874	2		RESISTOR, 2.2M ⅛W CARBON
	23	8264	4		RESISTOR, 1.5K ⅛W 1%
	[illegible]	7888	1		TEST JACK, GRAY
	21	7887	1		TEST JACK, YELLOW
	20	7846	4		RESISTOR, 47.5K ⅛W 1%
	19	7803	5		RESISTOR, 22.1K ⅛W 1%
	18	7860	3		RESISTOR, 15K ⅛W 1%
	17	7859	2		RESISTOR, 10K ⅛W 1%
	16	7856	4		RESISTOR, 4.75K ⅛W 1%
	15	7852	4		RESISTOR, 2.21K ⅛W 1%
	14	7837	2		CAPACITOR, 100 PF
	13	7835	2		CAPACITOR, 10 PF
	12	5476	2		POT, 20K
	11	5464	1		CAPACITOR, 25MF-12V NP
	10	5391	2		CAPACITOR, 470PF
	9	5030	2		CAPACITOR, 50MF-25V NP
	8	4950	2		CAPACITOR, .0015MF-100V 1%
	7	4585	2		SEMICOND., 2N3698
	6	4583	2		SEMICOND., 2N3568
	4	2878	AR		VARNISH
	3	2365	AR		SOLDER 60/40
D	2	2363	[illegible]		WIRE, #22 BARE TINNED COPPER
	1	9606			BOARD, ELECTRONIC SWITCH/INTEGR.

TOLERANCES UNLESS SPECIFIED OTHERWISE: FRACTIONS: ± 1/64" DECIMALS: ± 0.005" ANGLES: ± 1/2°

DRAWN BY	CHECKED BY	APPROVED BY	APPROVED BY	SCALE
R. [illegible] 7-14-76	[illegible] 7-26-76	[illegible] 4-4-77	[illegible] 4-4-77	REF. ONLY 2 X

TITLE: BOARD, ELECTRONIC SWITCH & INTEGRATOR PC ASM.

IRD MECHANALYSIS, INC. COLUMBUS, OHIO

DRAWING NUMBER D6-5664

(2) 2. FOR SCHEMATIC SEE DWG. D6-6233
1 APPLY VARNISH, ITEM #4, TO BOTH SIDES (A) OF BOARD AFTER ELECTRICAL CHECK.
NOTE:

Figure A-25 Electronic Switch and Integrator PC Board

LTR	REVISION	CHANGE ORDER	CK'D DATE	APP'D DATE
A	ADDED 'F' TO SHEET 1 DWG NOS. CORRECTED WIRE COLOR THAT WERE BLK 24G	150		
B	ADDED NOTES, 1 TO DETAIL FOR ITEM 31 & WIRE NOS. FOR CUTTING LIST. NOTE 2 & SCHEMATIC IDENTIFICATION NOS.	~	JR 5-29-74	
C	ADDED NOTE FOR ITEM 15E CHANGE QTY TO 2 FROM 1 WAS 0 INTERCHANGE. 1 & 17, REMOVED FROM	~	CATHEY 6-13-74	
D	ADDED 15K RES. P/N 7860. ADDED 11.8K RES. P/N R414. ITEM 21 P/N 9902 QTY 6 WAS QTY 7.	2240	72	
E	ITEM 33 WAS 11235 ITEM 48 WAS 2434 ADDED ITEM 49	2477	3-23-77	
F	F 50 & 50 - STADDED - WIRE LENGTHS WERE IN INCHES NOW IN FEET	2633	5-18-77	
G	COMBINED FIND NOS 48 & 49 TO ONE. UPDATED B/M	2699	B 3-77	
H	B/M UPDATE ONLY. NO DWG CHG	2699		
J	REVISED VIEW A-A	2709		
K	B/M UPDATE ONLY. NO DWG CHG	2699		
L	W/O NO. 117 WAS #97. REPLACED WIRE #97. ITEM 03 QTY 1.38 FT CHG TO ITEM 49 QTY 2.03 FOR QTY CHG IN CPU	2785	10-5-77	

NOTE:
1. APPLY VARNISH, ITEM '8, TO BOTH SIDES OF BOARD AFTER ELECTRICAL CHECK.
2. FOR SCHEMATIC SEE DWG. DG-6233

VIEW B-B

VIEW A-A

CONNECTOR
NUT
LOCK WASHER

MTG. DETAIL ITEM 31
ALL PARTS SUPPLIED WITH CONNECTOR.

ITEM NO.	PART NO.	NO. REQ.	DRAWING NO.	DESCRIPTION SPECIFICATION	MODEL	NEXT ASSEMBLY
51	90969	-	DG-6233	SCHEMATIC		
50	90964	-	DI-5848	CUT LIST, WIRE		
49	2422	2.03 FT		WIRE, WHITE/RED 22GA STRANDED		
48	2817	1.5 FT		CABLE, COAX		
47	2436	.25 FT		WIRE 22GA STR INS GRAY		
46	2435	.25 FT		WIRE 22GA STR INS. VIOLET		
45	2431	.25 FT		WIRE 22GA STR INS BROWN		
44	5547	1		TERMINAL, SPADE TOUNGE		
43						
42	2428	.75 FT		WIRE, WHITE/VIOLET 22GA STRANDED		
41	2420	.50 FT		WIRE, WHITE/BROWN 22GA STRANDED		
40	11242	1	B4-5830	HARNESS, WIRING MAIN PC B FRONT TO REAR		
39	11243	1	B4-5831	HARNESS, WIRING CKT BD TO FRONT PANEL APT		
38	11240	1	B4-5829	CABLE, FREQ RANGE SWITCH S1, S2, S3, S4, S5, S6 & S26		
37	11239	1	A4-5828	CABLE, FREQ RANGE SWITCH S7, S8, S9, S10, S11 & S26		
36	11238	1	A4-5827	CABLE, FREQ RANGE SWITCH S12 & S13		
35	7860	1		RESISTOR, 15K 1/8 W 1%		
34	11236	1	A4-5825	CABLE, FREQ, RANGE SWITCH S14 & S15		
33	2433	.50 FT		WIRE 22GA STR YELLOW		
32	2430	.75 FT		WIRE, 22 GA. BLACK		
31	11065	1		CONNECTOR AMP 329852-1		
30	10500	1	D4-4825	BOARD, MAIN PC		
29	10339	4		SCREW 4-40 X 1/8 PPHM		
28	9959	1	D3-5194	SWITCH RECORDER		
27	9958	1	D3-5195	SWITCH FUNCTION		
26	9957	1	D3-5196	SWITCH FREQ RANGE		
25	9947	4		GUIDE, CARD		
24	9946	2		CONNECTOR, 15 PIN		
23	9921	1		SEMICOND, MJE 3055		
22	9920	1		SEMICOND, MJE 2955		
21	9902	6		RESISTOR, 511 OHM 1/8 W 1%		
20	8788	1		RELAY, 6 VDC 1 FORM C 5A CONTACT		
19	9349	17		CONNECTOR 22 PIN		
18	7884	1		POT, 500 OHM		
17	7866	1		RESISTOR, 47.5K 1/8 W 1%		
16	7856	2		RESISTOR 4.75K 1/8 W 1%		
15	7848	1		RESISTOR, 1K 1/8 W 1%		
14	7175	68		WASHER, #4 FLAT BLACK		
13	8414	1		RESISTOR, 11.8K 1/8 W 1%		
12	5548	1		SEMICOND, IN4003		
11	5399	2		SEMICOND, IN5231B		
10	5212	.75 FT		WIRE, 22 GA BLUE TEFLON		
9	4535	24		SCREW, 4-40 X 3/8 PPHM		
8	2878	AR		VARNISH		
7	2365	AR		SOLDER, 60/40		
6	2363	1.5 FT		WIRE #22 GA BARE TINNED COPPER		
5	2346	AR		SPAGHETTI 3/16		
4	1907	4		WASHER #4 LOCK		
3	1871	4		NUT #4-40 HEX		
2	1585	1		RESISTOR, 330 OHM 1/2 W 5%		
1	10501	1		BOARD, MAIN P.C. ASM.	360	D2-4850

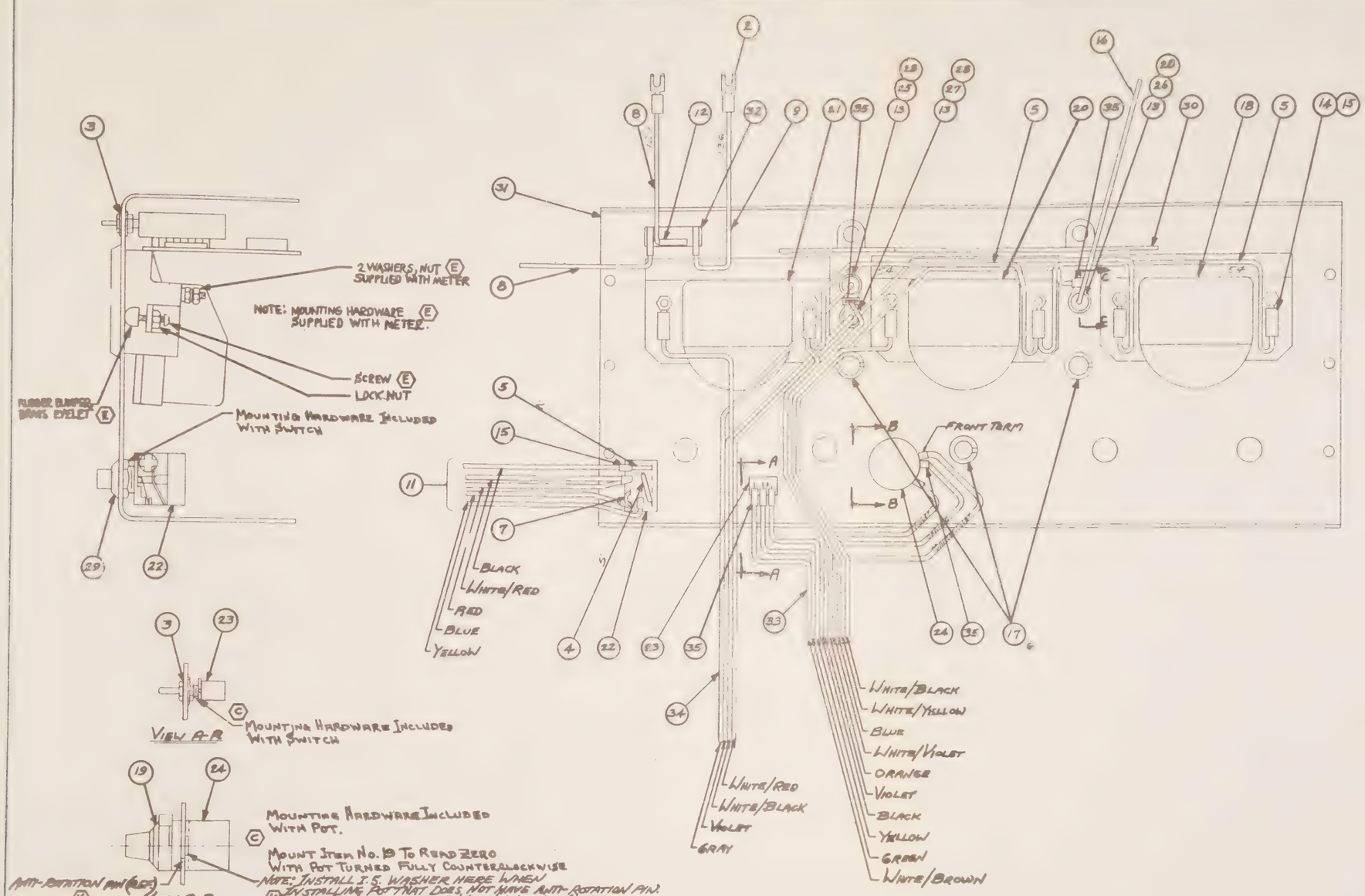
TOLERANCES, UNLESS SPECIFIED OTHERWISE
FRACTIONS ± 1/64" DECIMALS ± 0.005" ANGLES ± 1/2°

DRAWN BY: B. 2-16-76 | CHECKED BY: [illegible] | APPROVED BY: [illegible] | SCALE: REF ONLY | SIZE: FULL

TITLE: BOARD - MAIN P.C. ASM.

IRD MECHANALYSIS, INC. COLUMBUS, OHIO | DRAWING NUMBER D2-5740 | L | SHEET 1 of 1

Figure A-26 Main PC Board



LTR	REVISION	CHANGE ORDER	CK'D DATE	APPL DATE
A	REV'D WIRE ROUTING [illegible] WIRE NO'S	~	[illegible] 2-13-74	1
B	ADD [illegible] REVISED TO 5 PLACES .12"	~	LATHROP 3-27-74	[illegible]
C	[illegible]	~	LATHROP 6-13-74	[illegible]
D	[illegible]	1442	LATHROP [illegible]	[illegible]
E	INCORPORATED SKETCH 1111746CR1	1992	LATHROP 12-3-74	12-9-74
F	ADDED FIND NO 36 WIRE LENGTHS WERE IN INCHS	2695	[illegible] 6-11-77	[illegible]
G	ITEM 17 NO REQ WAS 1	2587	[illegible] 11-77	[illegible]
H	ITEM 31 WAS P/N 10228, C4-4927.	2764	[illegible] [illegible]	[illegible]
J	ITEM 16 WAS 2.92 FT. RMVD TERMINAL (ON DWG ITEM 16.	2785	[illegible] 10-5-77	[illegible]
K	ANTI-ROTATION PIN NOTE ADDED. WAS FLUSH/SHORT. NOTE ADDED.	2780	[illegible] 10-6-77	[illegible]
L	ITEM 37 WAS 16 CHG DUE TO CPU NOT ACCEPTING QTY CHG REV J	2699	[illegible] 11-9-77	[illegible] 11-9-77

ITEM NO.	PART NO.	NO. REQ.	DRAWING NO.	DESCRIPTION / SPECIFICATION
(L) 37	2429	16"		WIRE #22GA STR. SIL. RED
(F) 36	90964	-	D1-5848	WIRE CUT-LIST
35	2345	AR		SPAGHETTI, #14
34	11241	1	D4-5849	CABLE, REAR OF MAIN PCB TO FRONT OF INSTR.
33	11245	1	D4-5780	HARNESS, FRONT PANEL
32	10355	1		SWITCH, LIGHTED ROCKER
31	17477	1	CA-11787	PANEL, FRONT
30	10003	1	D2-5697	BOARD, DIGITAL SWEEP FREQ, LIMIT ASM.
29	9998	1		BEZEL, RESET SWITCH
28	9968	3		LAMP 5V 60 MA
27	9967	1		INDICATOR, BLUE LENS
26	9966	1		INDICATOR, AMBER LENS
25	9964	1		INDICATOR, RED LENS
24	9963	1		POT, 10K 10T
23	9954	1		SWITCH, TOGGLE MODEL ST1-1
22	9953	1		SWITCH, RESET
(D) 21	12039	1	D3-6488	METER, PHASE
(D) 20	12038	1	D3-6487	METER, FREQUENCY
19	9220	1		DIAL, POT TURNS COUNTER MODEL 69
18	8268	1	D9-3710	METER, AMPLITUDE
(G) 17	7941	3		NYLNER
(L)(J) 16				
15	2346	AR		SPAGHETTI, #16
14	1530	6		LUG, #6 I.S. 4 TONGUE SOLDER
13	1829	3		LUG, 1/4 I.S. SHORT TONGUE SOLDER
12	11406	3		TERMINAL, FEMALE FLAG
11	11246	1	C4-5849	HARNESS, RESET SWITCH
10	4406	AR		TIES, SELF CLINCHING
9	2416	24"		WIRE, #18 GA STR INS. WHITE
8	2418	9.25"		WIRE, #18 GA STR INS. BLACK
7	2363	AR		WIRE #23 GA BARE TINNED COPPER
6	2365	AR		SOLDER, 60/40
5	2430	24"		WIRE, #22 GA STR INS. BLACK
4	2421	24"		WIRE, #22 GA STR INS. WHITE.
3	4249	3		WASHER, 1/4 I.D. x 3/8 O.D. x .005 THK.
2	8549	3		TERMINAL, 3/4 6342 SPADE TONGUE SOLDERLESS
1	10806	1		PANEL, FRONT ASM. 360 D2-4850 1

TOLERANCES UNLESS SPECIFIED OTHERWISE: FRACTIONS: ± 1/64" DECIMALS: ± .005" ANGLES: ± 1/2°

DRAWN BY: J. Gagel CHECKED BY: MAT. 12/74 APPROVED BY: [illegible] APPROVED BY: [illegible] SCALE: REF. ONLY

TITLE: PANEL-FRONT ASM.

IRD MECHANALYSIS, INC. COLUMBUS, OHIO

DRAWING NUMBER D2-4842 L SHEET 1 OF 1

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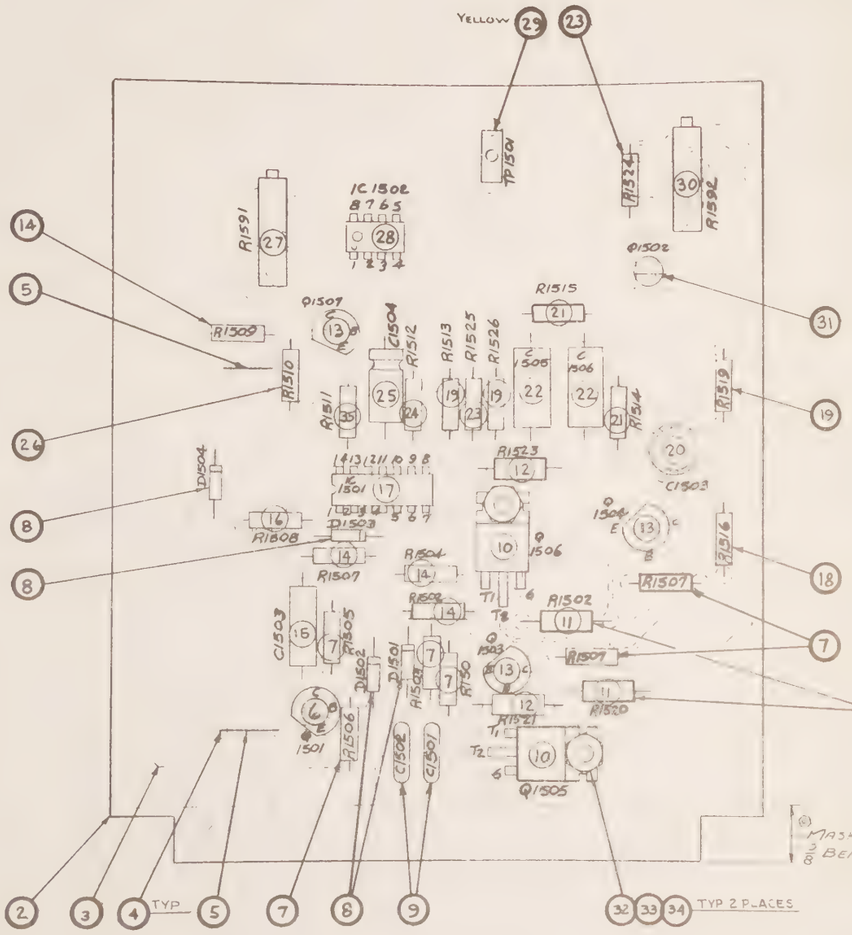
Figure A-27 Front Panel Assembly

LTR	REVISION	CHANGE ORDER	CK'D DATE	APP'D DATE
A	ADDED "E" & 32, 33 & 34 & NOTE #1 & #2	~	LATHROP 9-25-73	—
B	ADDED ITEM 35 & REV SHAN ITEM 21 W/13 REQ.	~	LATHROP 10-17-73	—
C	ADDED MTG DETAIL FOR ITEM 11 & NOTE #2	~	[illegible] 3-6-74	[illegible]
D	ADDED COMPONENT DESIG NO. & NOTE #2	—	LATHROP 5-20-74	[illegible]
E	ITEM 11 WAS P/N 9878.	2653	[illegible]	[illegible]
F	ADDED FIND NOS. 36+37 FIND NO.5 WAS AR REQ'D.	2635	[illegible] 5-10 [illegible]	[illegible] 5-31-77



ITEM NO	PART NO.	NO. REQ.	DRAWING NO.	DESCRIPTION / SPECIFICATION	MODEL	NEXT ASSEMBLY
37	90474	-		QCI-2-48 360 PHASE CONTROL LIGHTS & RECORDER PCB		
36	90369	-	D6-6233	SCHEMATIC		
B 35	8531	1		RESISTOR - 97.6K 1/8W 1%		
34	1907	2		WASHER #4 I.S. LOCK CAD PLATE		
33	9570	2		NUT #4-40 NYLON		
32	9569	2		SCREW #4-40 x 3/8 SLOT HEAD NYLON		
31	4826	1		SEMICOND - 2N3391		
30	8337	1		POT - 5K		
29	7887	1		TEST JACK - YELLOW		
28	8555	1		SEMICOND - 741 MINI-DIP		
27	7884	1		POT - 500Ω		
26	7868	1		RESISTOR - 100K 1/8W 1%		
25	1473	1		CAPACITOR - 1MFD 50V		
24	7862	1		RESISTOR - 21.5K 1/8W 1%		
23	7856	2		RESISTOR - 4.75K 1/8W 1%		
22	9342	2		CAPACITOR - .1MFD 80V 10%		
B 21	7867	2		RESISTOR - 68.1K 1/8W 1%		
20	8554	1		SEMICOND - MC-1458		
19	7848	3		RESISTOR - 1K 1/8W 1%		
18	7870	1		RESISTOR - 332K 1/8W 1%		
17	9925	1		SEMICOND - CD 4013AE		
16	7860	1		RESISTOR - 15K 1/8W 1%		
15	5040	1		CAPACITOR - .01MFD 200V		
14	7863	4		RESISTOR - 22.1K 1/8W 1%		
13	4583	3		SEMICOND - 2N3568		
12	586	2		RESISTOR - 470Ω 1/2W 5%		
B 11	16511	2		RESISTOR - 300Ω 2 1/4W 5%		
10	9322	2		SEMICOND - 40668		
9	5342	2		CAPACITOR - 270 PF		
8	5398	4		SEMICOND - 1N914		
7	7859	6		RESISTOR - 10K 1/8W 1%		
6	456	1		SEMICOND - 2N3638		
F 5	2363	.06'		WIRE - BARE		
4	2365	AR		SOLDER - 60/40		
3	2878	AR		VARNISH		
2	10018	1	C4-5011	BOARD - PC		
1	9615			BOARD - PHASE CONT. LIGHTS PC ASM 360	D2-4851	1

TOLERANCES UNLESS SPECIFIED OTHERWISE: FRACTIONS: ± 1/64" DECIMALS: ± 0.005" ANGLES: ± 1/2°

DRAWN BY: R. CARL 7-21-1972 | CHECKED BY: [illegible] 8-20-1972 | APPROVED BY: [illegible] 9-[illegible]-72 | APPROVED BY: [illegible] 10-[illegible]-72 | SCALE: REF. ONLY 2:1

TITLE: BOARD-PHASE CONTROL LIGHTS & RECORDER DC OUTPUT PC ASM

IRD MECHANALYSIS, INC. COLUMBUS, OHIO

DRAWING NUMBER: D2-5594

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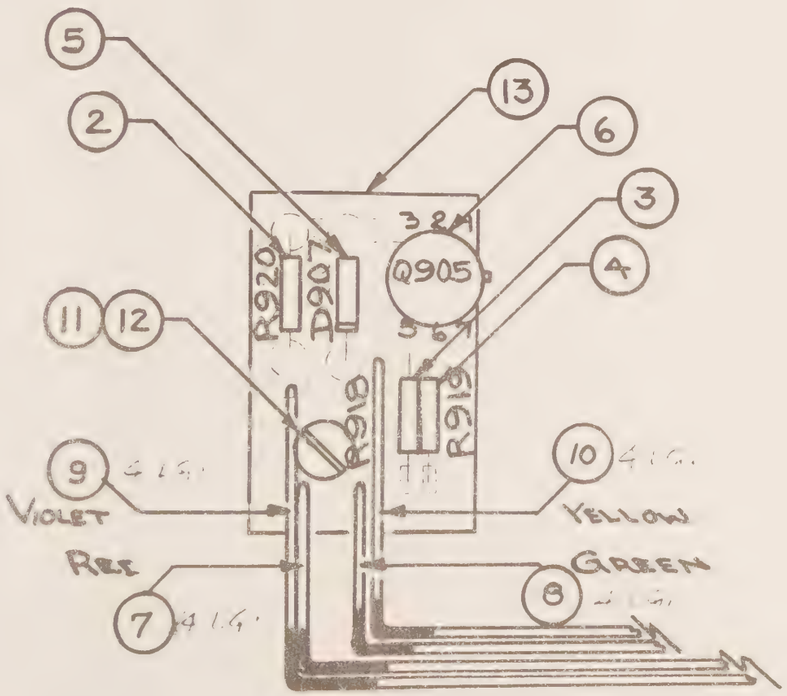
© 2. FOR SCHEMATIC SEE D6-6233

© 1. APPLY VARNISH, ITEM #3, TO BOTH SIDES OF BOARDS AFTER ELECTRICAL CHECK.

NOTE:

Figure A-28 Phase Control Lights and Recorder DC Output PC Board

LTR.	REVISION	CHANGE ORDER	C'K'D DATE	APP'D DATE



ITEM NO.	PART NO.	NO. REQ.	DRAWING NO.	DESCRIPTION / SPECIFICATION	MODEL	NEXT ASSEMBLY	NO. REQ.
15	2365	AR		SOLDER, 60/40			
14	2878	AR		VARNISH			
13	12671	1	A4-7145	BOARD, DIGITAL SWEEP TEMP MOD.			
12	9569	1		SCREW, 4-40 x 3/8 SLOTTED ROUND HEAD NYLON			
11	9570	1		NUT, 4-40 HEX NYLON			
10	2433	4"		WIRE, #22 GA. 19 STR. INS. YELLOW			
9	2431	4"		WIRE, #22 GA. 19 STR. INS. VIOLET			
8	2432	4"		WIRE, #22 GA. 19 STR. INS. GREEN			
7	2429	4"		WIRE, #22 GA. 19 STR. INS RED			
6	5092	1		SEMICOND, 2N3806			
5	5389	1		SEMICOND, 1N5231B			
4	9716	1		RESISTOR, 43.2K 1/8 W 1%			
3	9274	1		RESISTOR, 20K 1/8 W 1%			
2	7861	1		RESISTOR, 18.2 K 1/8 W 1%			
1	12670			BOARD, DIGITAL MOD.	360	D2-5674	1

TOLERANCES UNLESS SPECIFIED OTHERWISE
FRACTIONS: ± 1/64" DECIMALS: ± 0.005" ANGLES: ± 1/2°

DRAWN BY	CHECKED BY	APPROVED BY	APPROVED BY	SCALE
MCKINLEY				REF. ONLY
6-3 1975	6-13 1975	19	19	2×1

TITLE: BOARD, DIGITAL SWEEP TEMP. MOD. ASM.

IRD MECHANALYSIS, INC.
COLUMBUS, OHIO

DRAWING NUMBER B2-7144

SHEET 1 OF 1

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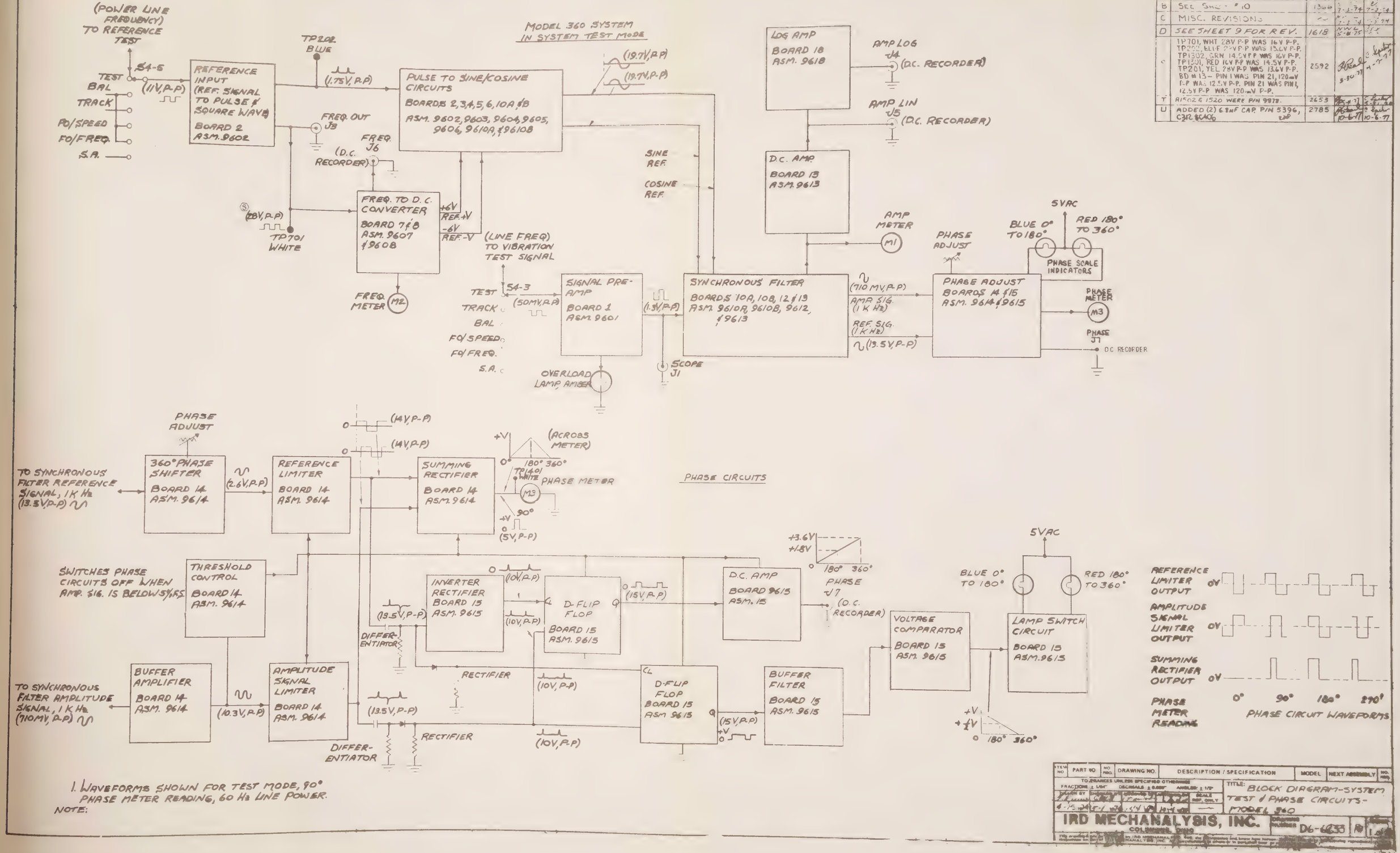
2. FOR SCHEMATIC SEE DWG D6-6233
1. APPLY VARNISH, ITEM #14, TO BOTH SIDES OF BOARD AFTER ELECTRICAL CHECK

NOTES:

Figure A-29 Digital Sweep Temperature Module

LTR	REVISION	CHANGE ORDER	CK'D DATE	APP'D DATE
A	MISC. CHECKING CHANGES INCORP.	~	NWL 5-1-74	
B	SEE SHT. # 10	1366	7-2-74	7-3-74
C	MISC. REVISIONS	~	7-2-74	7-3-74
D	SEE SHEET 9 FOR REV.	1618	NWL 5-8-75	
E	TP701, WHT 28V P-P WAS 16V P-P. TP202, BLUE 20 V P-P WAS 15.6V P-P. TP1302, GRN 14.5V P-P WAS 16V P-P. TP1201, RED 16V P-P WAS 14.5V P-P. TP201, YEL 28V P-P WAS 13.6V P-P. BD # 13 - PIN 1 WAS PIN 21, 120 mV P-P WAS 12.5V P-P. PIN 21 WAS PIN 1, 12.5V P-P WAS 120 mV P-P.	2592	5-30-77	
T	R1502 & 1520 WERE P/N 9878.	2653		
U	ADDED (2) 6.8 mF CAP. P/N 5396, C3R, C4A/C6	2785	10-6-77	10-6-77



NOTE:
1. WAVEFORMS SHOWN FOR TEST MODE, 90° PHASE METER READING, 60 Hz LINE POWER.

ITEM NO	PART NO	NO REQ.	DRAWING NO.	DESCRIPTION / SPECIFICATION	MODEL	NEXT ASSEMBLY	NO. REQ.

TOLERANCES UNLESS SPECIFIED OTHERWISE: FRACTIONS ± 1/64" DECIMALS ± 0.005" ANGLES: ± 1/2°

DRAWN BY [illegible] CHK'D [illegible] ENG APP'D [illegible] DATE 4-1-74 SCALE NOT ONLY

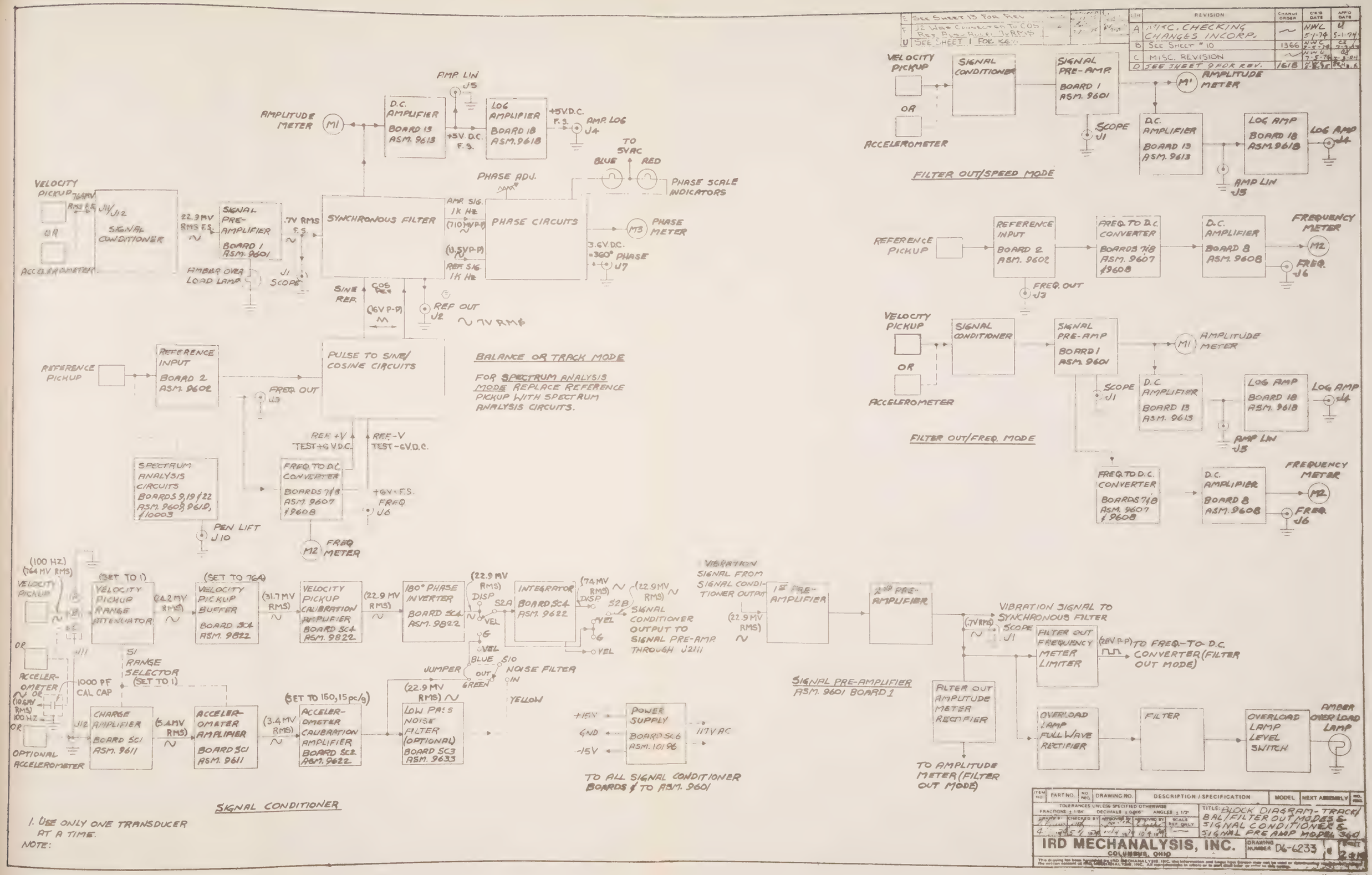
TITLE: BLOCK DIAGRAM-SYSTEM TEST & PHASE CIRCUITS-MODEL 360

IRD MECHANALYSIS, INC. COLUMBUS, OHIO

DRAWING NUMBER D6-6833 REV P SHEET 1 OF 1

Figure A-30 Block Diagram of System Test and Phase Circuits

LTR	REVISION	CHANGE ORDER	CK'D DATE	APP'D DATE
A	P.C. CHECKING CHANGES INCORP.	~	NWC 5-1-74	5-1-74
B	SEE SHEET 10	1366	NWC 7-5-74	7-3-74
C	MISC. REVISION	~	NWC 7-5-74	7-3-74
D	SEE SHEET 9 FOR REV.	1618	7-25-74	8-6



ITEM NO.	PART NO.	NO. REQ.	DRAWING NO.	DESCRIPTION / SPECIFICATION	MODEL	NEXT ASSEMBLY	NO. REQ.

TOLERANCES UNLESS SPECIFIED OTHERWISE: FRACTIONS ± 1/64" DECIMALS ± 0.005" ANGLES ± 1/2°

DRAWN BY | CHECKED BY | APPROVED BY | APPROVED BY | SCALE: NOT TO SCALE

TITLE: BLOCK DIAGRAM - TRACK/BAL/FILTER OUT MODES & SIGNAL CONDITIONER & SIGNAL PRE AMP MODEL 360

IRD MECHANALYSIS, INC. COLUMBUS, OHIO

DRAWING NUMBER D6-6233 | SHEET 1 OF 2

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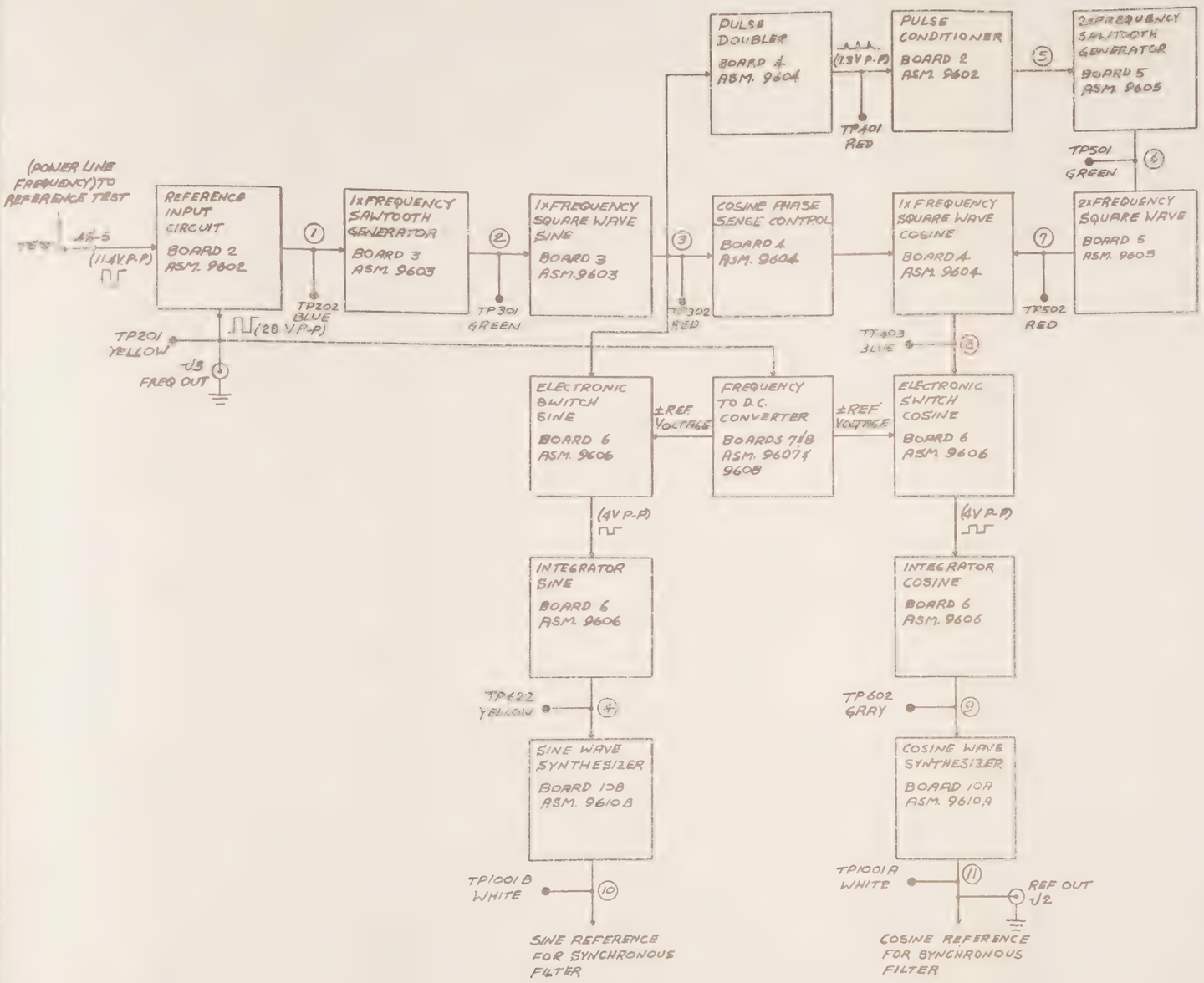
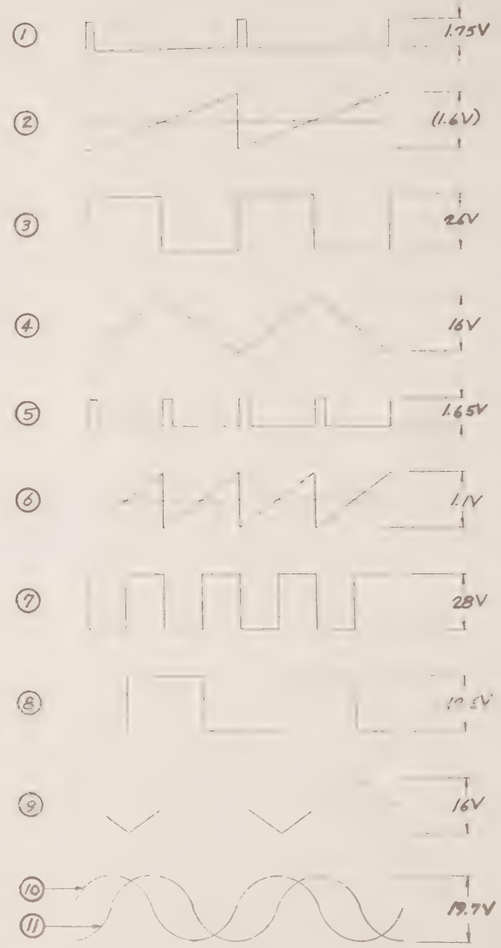
Figure A-31 Block Diagram of Track Balance Filter Out Modes and Signal Conditioner and Signal Preamplifier Circuits

LTR	REVISION	CHANGE ORDER	C'K'D DATE	APP'D DATE
A	MISC. CHECKING CHANGES INCORP.	~	NWL 5-1-74	CJ 5-1-74
B	SEE SHEET #10	1366	NWL 7-3-74	CJ 7-3-74
C	MISC. REVISIONS	~	NWL 7-3-74	CJ 7-3-74
U	SEE SHEET 1 FOR REV.			





NOTE: . WAVE FORMS SHOWN FOR TEST MODE

ITEM NO.	PART NO.	NO. REQ.	DRAWING NO.	DESCRIPTION / SPECIFICATION	MODEL	NEXT ASSEMBLY	NO. REQ.

TOLERANCES UNLESS SPECIFIED OTHERWISE
FRACTIONS ± 1/64" DECIMALS ± 0.005" ANGLES ± 1/2°

DRAWN BY	CHECKED BY	APPROVED BY	APPROVED BY	SCALE
J. Rowe			R. Ryder	REF. ONLY
4 JC 9/4/73		10/4 1974	10-4 1974	

TITLE: BLOCK DIAGRAM - PULSE TO SINE/COSINE CIRCUITS MODEL 360

IRD MECHANALYSIS, INC.
COLUMBUS, OHIO

DRAWING NUMBER D6-6233 SHEET 13 OF 14

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Figure A-32 Block Diagram of Pulse to Sin/Cosin Circuits

LTR	REVISION	CHANGE ORDER	CKD DATE	APP'D DATE
A	MISC. CHECKING	~	NWL 5-1-74	[illegible]
B	SEE SHEET #10	1366	NWL 7-3-74	[illegible]
C	MISC. REVISIONS	~	NWL 7-3-74	[illegible]
U	SEE SHEET 1 FOR REV.			

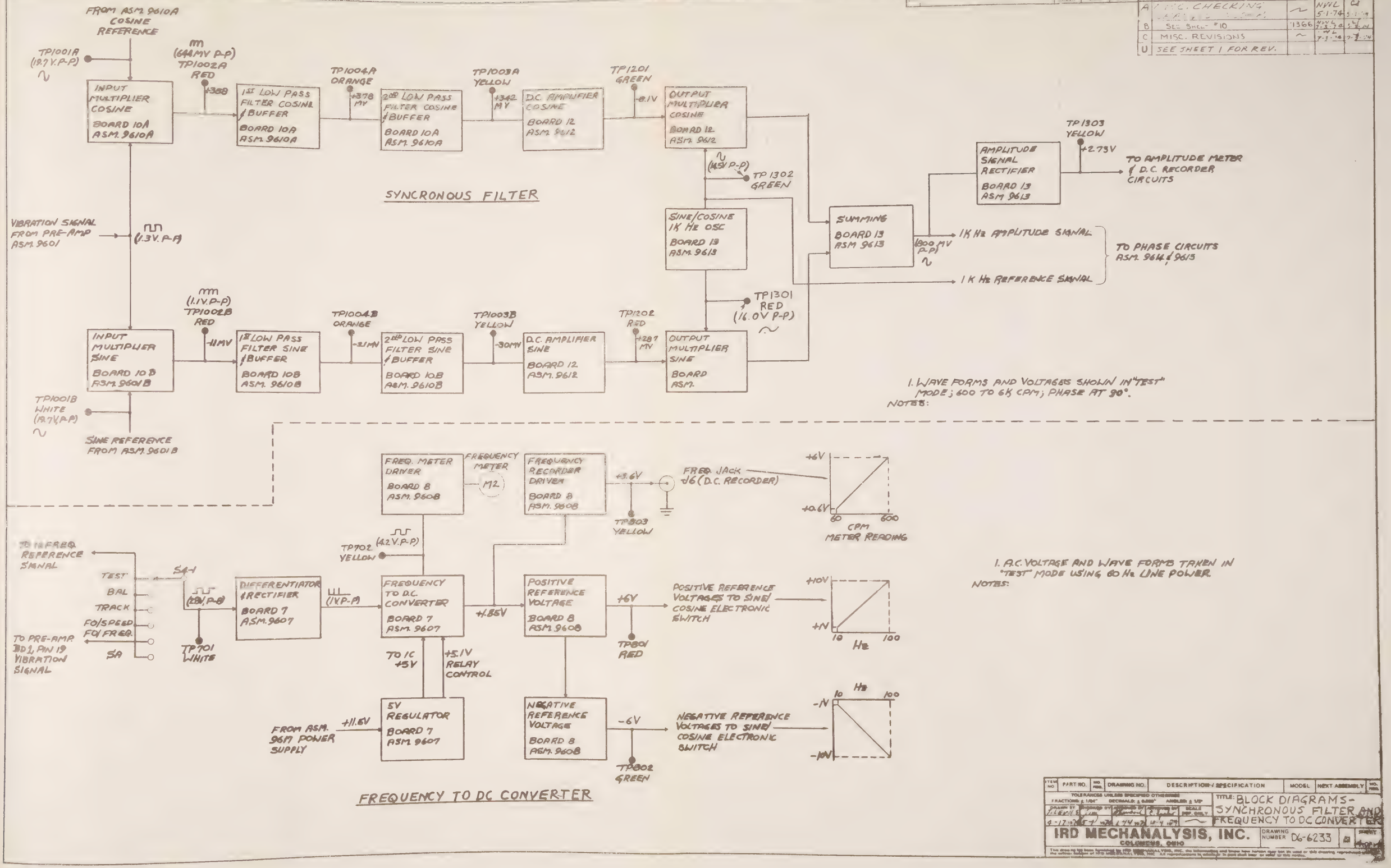
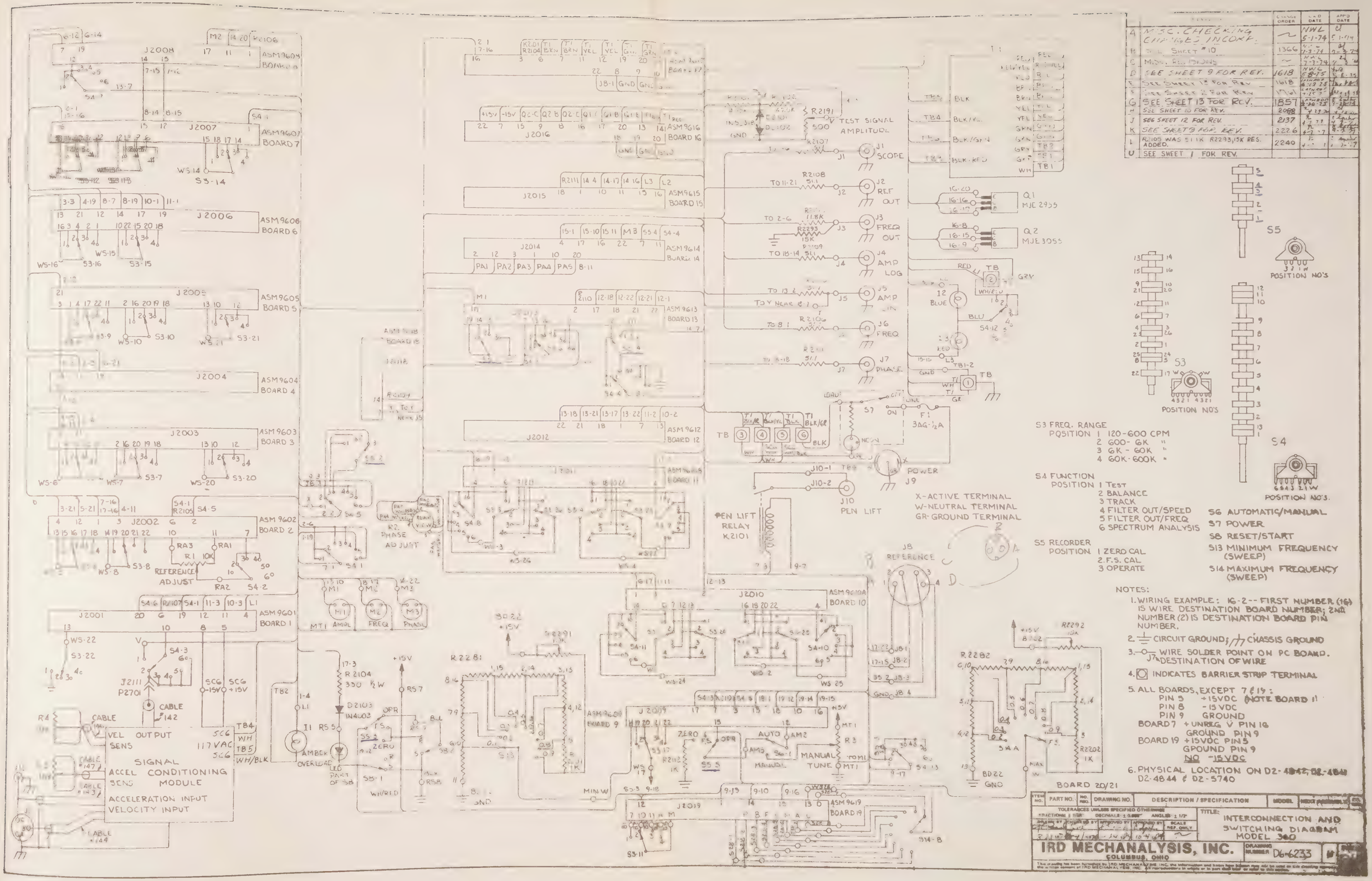

FROM ASM 9610A COSINE REFERENCE
TP1001A (19.7 V.P-P)
(644 MV P-P) TP1002A RED
+388
INPUT MULTIPLIER COSINE BOARD 10A ASM. 9610A
1ST LOW PASS FILTER COSINE & BUFFER BOARD 10A ASM. 9610A
TP1004A ORANGE
+378 MV
2ND LOW PASS FILTER COSINE & BUFFER BOARD 10A ASM. 9610A
TP1003A YELLOW
+342 MV
D.C. AMPLIFIER COSINE BOARD 12 ASM. 9612
TP1201 GREEN
-8.1V
OUTPUT MULTIPLIER COSINE BOARD 12 ASM. 9612
SYNCRONOUS FILTER
(1.3V. P-P)
VIBRATION SIGNAL FROM PRE-AMP ASM. 9601
(1.1V. P-P) TP1002B RED
-11MV
INPUT MULTIPLIER SINE BOARD 10B ASM. 9601B
1ST LOW PASS FILTER SINE & BUFFER BOARD 10B ASM. 9610B
TP1004B ORANGE
-21MV
2ND LOW PASS FILTER SINE & BUFFER BOARD 10B ASM. 9610B
TP1003B YELLOW
-30MV
D.C. AMPLIFIER SINE BOARD 12 ASM. 9612
TP1202 RED
+287 MV
OUTPUT MULTIPLIER SINE BOARD ASM.
TP1001B WHITE (19.7V.P-P)
SINE REFERENCE FROM ASM. 9601B
(1 V P-P)
TP1302 GREEN
SINE/COSINE 1K HZ OSC BOARD 13 ASM. 9613
TP1301 RED (16.0V P-P)
SUMMING BOARD 13 ASM 9613
1900 MV P-P
1K Hz AMPLITUDE SIGNAL
1 K Hz REFERENCE SIGNAL
TO PHASE CIRCUITS ASM. 9614 & 9615
AMPLITUDE SIGNAL RECTIFIER BOARD 13 ASM 9613
TP1303 YELLOW
+2.73V
TO AMPLITUDE METER & D.C. RECORDER CIRCUITS
NOTES:
1. WAVE FORMS AND VOLTAGES SHOWN IN "TEST" MODE; 600 TO 6K CPM; PHASE AT 90°.
FREQ. METER DRIVER BOARD 8 ASM. 9608
FREQUENCY METER
M2
FREQUENCY RECORDER DRIVER BOARD 8 ASM. 9608
+3.6V
TP803 YELLOW
FREQ. JACK J6 (D.C. RECORDER)
+6V
+0.6V
60
600
CPM METER READING
TO 1A FREQ. REFERENCE SIGNAL
TEST
BAL
TRACK
FO/SPEED
FO/FREQ.
SA
SA-1
TO PRE-AMP BD 1, PIN 19 VIBRATION SIGNAL
(20V. P-P)
TP701 WHITE
DIFFERENTIATOR & RECTIFIER BOARD 7 ASM. 9607
(1V P-P)
TP702 YELLOW
(4.2V. P-P)
FREQUENCY TO D.C. CONVERTER BOARD 7 ASM. 9607
+1.85V
TO IC +5V
+5.1V RELAY CONTROL
5V REGULATOR BOARD 7 ASM 9607
FROM ASM. 9617 POWER SUPPLY
+11.6V
POSITIVE REFERENCE VOLTAGE BOARD 8 ASM. 9608
+6V
TP801 RED
POSITIVE REFERENCE VOLTAGES TO SINE/COSINE ELECTRONIC SWITCH
+10V
+1V
10
100
Hz
NEGATIVE REFERENCE VOLTAGE BOARD 8 ASM. 9608
-6V
TP802 GREEN
NEGATIVE REFERENCE VOLTAGES TO SINE/COSINE ELECTRONIC SWITCH
-1V
-10V
10
Hz
100
1. A.C. VOLTAGE AND WAVE FORMS TAKEN IN "TEST" MODE USING 60 Hz LINE POWER.
NOTES:
FREQUENCY TO DC CONVERTER
ITEM NO. | PART NO. | NO. REQ. | DRAWING NO. | DESCRIPTION / SPECIFICATION | MODEL | NEXT ASSEMBLY | NO. REQ.
TOLERANCES UNLESS SPECIFIED OTHERWISE: FRACTIONS ± 1/64" DECIMALS ± 0.005" ANGLES ± 1/2°
DRAWN BY | CHECKED BY | ENGINEER BY | SCALE
TITLE: BLOCK DIAGRAMS - SYNCHRONOUS FILTER AND FREQUENCY TO DC CONVERTER
IRD MECHANALYSIS, INC. COLUMBUS, OHIO
DRAWING NUMBER D6-6233
SHEET

Figure A-33 Block Diagram of Synchronous Filter and Frequency to DC Converter Circuits



		CHANGE ORDER	L.A.D. DATE	APPD DATE
A	MISC. CHECKING CHANGES INCORP.	~	NWL 5-1-74	5-1-74
B	SEE SHEET #10	1366	5-3-74	5-3-74
C	MISC. REVISIONS	~	NWL 7-3-74	7-3-74
D	SEE SHEET 9 FOR REV.	1618	NWL 5-8-75	5-8-75
E	SEE SHEET 12 FOR REV	1618	5-19-75	5-19-75
F	SEE SHEET 2 FOR REV	1760	7-25-75	7-25-75
G	SEE SHEET 13 FOR REV.	1857	10-20-75	10-20-75
H	SEE SHEET 10 FOR REV.	2088	4-23-76	4-23-76
J	SEE SHEET 12 FOR REV.	2137	6-7-76	6-7-76
K	SEE SHEET 9 FOR REV.	2226	6-7-76	6-7-76
L	R2105 WAS 511K R2293,15K RES. ADDED.	2240	12-1-76	12-7-76
U	SEE SHEET 1 FOR REV.			

Figure A-34 Diagram of Interconnection and Switching Circuits

LTR	REVISION	CHANGE ORDER	CKD DATE	APPD DATE
A	MISC. CHECKING CHANGES INCORP.	~	NWL 5-1-74	5-1-74
B	SEE SHEET 10	1366	NWL 7-2-74	7-3-74
C	MISC. REVISIONS	~	NWL 7-5-74	7-8-74
D	SEE SHEET 9 FOR REV.	1618	NWL 8-8-75	8-8-75
E	SEE SHEET 3 FOR REV.	1618	NWL 8-27-75	8-28-75
F	SEE SHEET 2 FOR REV.	1716	NWL 11-21-75	11-21-75
U	SEE SHEET 1 FOR REV.			

SIGNAL CONDITIONER OUTPUT

BOARD SC4 ASM# 9822

BUFFER BB3503A

180° PHASE INVERTER

INTEGRATOR C2605 .033 1%

BOARD SC1 ASM# 9611

BOARD SC2 ASM#9622

BOARD SC3 ASM.#9333

BOARD SC6 ASM#10196

BD SC5 ASM#9821

POWER SUPPLY A# 9721

LOW PASS NOISE FILTER (OPTIONAL)

CHARGE AMPLIFIER

ACCELEROMETER AMPLIFIER

ACCELEROMETER CALIBRATION AMPLIFIER

NOISE FILTER

6. CAPACITOR VALUES ARE MFD UNLESS OTHERWISE NOTED
5. ALL WIRE CONNECTION POINTS GO TO BD. SC5 ASM.# 9821
4. R.C. VOLTAGES & WAVE FORMS TAKEN AT 100 Hz ON '1' RANGE VELOCITY 764 MV RMS INPUT AND SENSITIVITY; ACCELERATION 10.6 MV RMS INPUT THRU 1000 PF AND 15 PK/G SENSITIVITY.
3. R.C. VOLTAGES ARE SIN WAVES UNLESS OTHERWISE SHOWN.
2. ALL RESISTORS 1% 1/8 W METAL FILM UNLESS OTHERWISE NOTED.
1. INTERCONNECTION BOARD FOR SC1 THRU SC4 IS SC5.

NOTES:

FOR BOARD SC1 SEE C2-5698
" " SC2 " C2-5704
" " SC3 " C2-5699
" " SC4 " C2-5703
" " SC5 " D2-5709
SC6 C2-5706

BD SC1, SC2, SC3, SC4 & SC6

ITEM NO.	PART NO.	NO. REQ.	DRAWING NO.	DESCRIPTION / SPECIFICATION	MODEL	NEXT ASSEMBLY

TOLERANCES UNLESS SPECIFIED OTHERWISE
FRACTIONS ± 1/64" DECIMALS ± 0.005" ANGLES: ± 1/2°

TITLE: SCHEMATIC - MODEL 960 SIGNAL CONDITIONER

IRD MECHANALYSIS, INC.
COLUMBUS, OHIO

Figure A-35 Schematic Diagram of Signal Conditioner Circuits

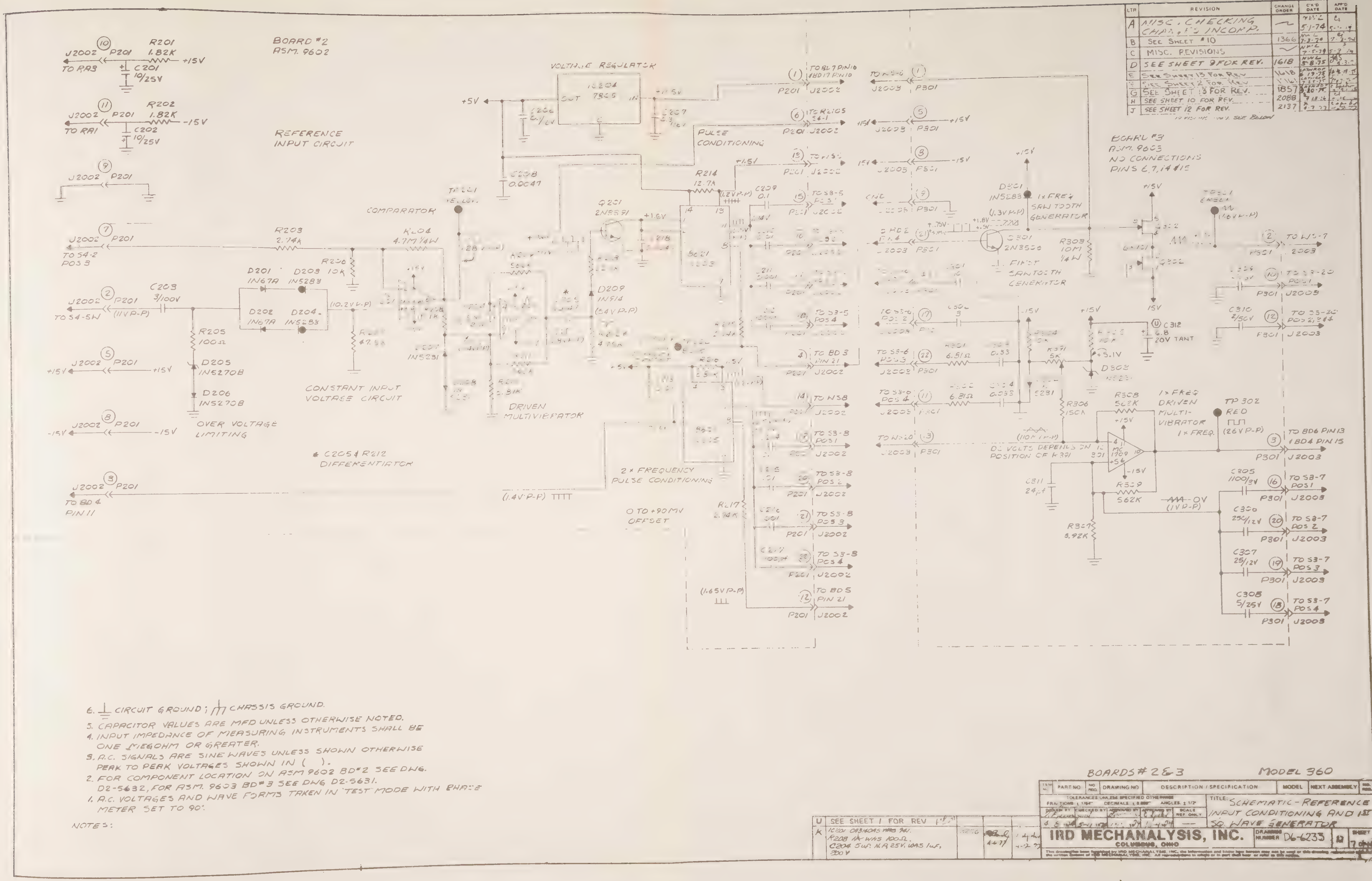
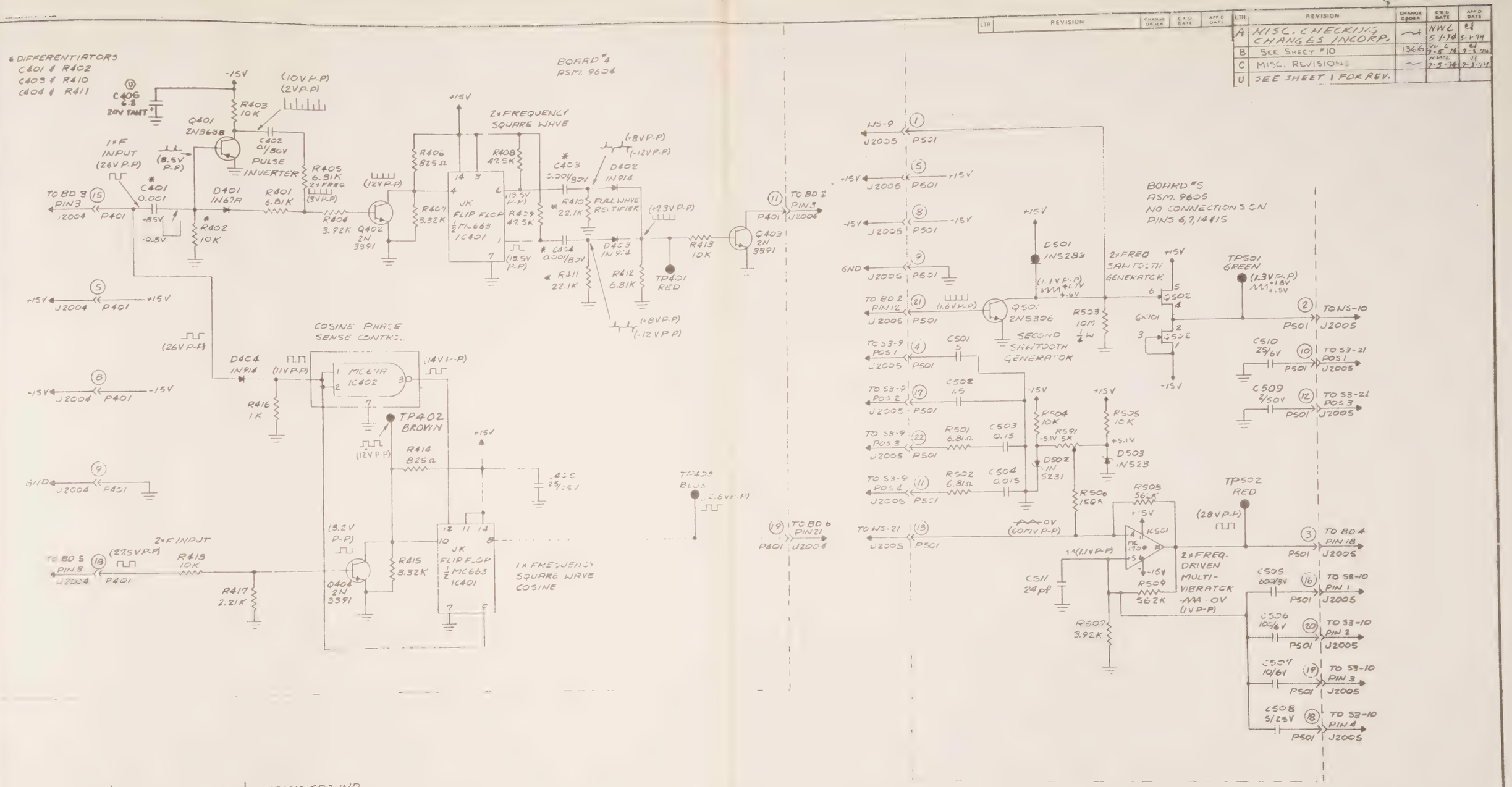

BOARD #2
ASM. 9602
J2002 P201 R201 1.82K +15V
TO RA3
C201 10/25V
R202 1.82K -15V
TO RA1
C202 10/25V
REFERENCE INPUT CIRCUIT
TO 54-2 POS 3
R203 2.74K
COMPARATOR
D201 1N67A
D203 1N5283
R206 10K
C203 3/100V
(11V P-P)
TO 54-5W
D202 1N67A
D204 1N5283
(10.2V P-P)
R205 100Ω
D205 1N5270B
D206 1N5270B
OVER VOLTAGE LIMITING
CONSTANT INPUT VOLTAGE CIRCUIT
* C205 & R212 DIFFERENTIATOR
TO BD 4 PIN 11
VOLTAGE REGULATOR
+5V
7805
OUT
IN
C208 0.0047
Q201 2N3391
+1.6V
D209 1N914
(54V P-P)
DRIVEN MULTIVIBRATOR
R214 12.7K
(1.2V P-P)
C209 0.1
+1.5V
PULSE CONDITIONING
TO BL7 PIN 10 & BD17 PIN 10
TO R2105 S4-1
TO S3-5 POS 4
TO BD 3 PIN 21
TO WS8
TO S3-8 POS 1
TO S3-8 POS 2
TO S3-8 POS 3
TO S3-8 POS 4
TO BD 5 PIN 21
2 × FREQUENCY PULSE CONDITIONING
(1.4V P-P)
0 TO +90MV OFFSET
R217 2.74K
(1.65V P-P)
P201 J2002
J2003 P301
BOARD #3
ASM. 9603
NO CONNECTIONS PINS 6,7,14 & 15
D301 1N5283
1 × FREQ SAW TOOTH GENERATOR
(1.3V P-P)
Q301 2N3566
FIRST SAWTOOTH GENERATOR
R303 10M 1/4W
TO WS-7
C310 2/50V
TO S3-20 POS 2,3 & 4
C312 6.8 20V TANT
+5.1V
D303
R301 6.51Ω
0.33
R371 5K
6.81Ω
0.033
R306 150K
R308 562K
1 × FREQ DRIVEN MULTIVIBRATOR
TP 302 RED
(26V P-P)
1 × FREQ.
MC 1709
TO BD6 PIN 13 & BD4 PIN 15
DC VOLTS DEPENDS ON POSITION OF R371
C311 24pf
R309 562K
0V (1V P-P)
R307 3.92K
C305 1100/3V
TO S3-7 POS 1
C306 250/12V
TO S3-7 POS 2
C307 25/12V
TO S3-7 POS 3
C308 5/25V
TO S3-7 POS 4
6. CIRCUIT GROUND; CHASSIS GROUND.
5. CAPACITOR VALUES ARE MFD UNLESS OTHERWISE NOTED.
4. INPUT IMPEDANCE OF MEASURING INSTRUMENTS SHALL BE ONE MEGOHM OR GREATER.
3. A.C. SIGNALS ARE SINE WAVES UNLESS SHOWN OTHERWISE PEAK TO PEAK VOLTAGES SHOWN IN ( ).
2. FOR COMPONENT LOCATION ON ASM 9602 BD#2 SEE DWG. D2-5632, FOR ASM. 9603 BD#3 SEE DWG D2-5631.
1. A.C. VOLTAGES AND WAVE FORMS TAKEN IN "TEST" MODE WITH PHASE METER SET TO 90°.
NOTES:
REVISION
A MISC. CHECKING CHANGES INCORP.
B SEE SHEET #10
C MISC. REVISIONS
D SEE SHEET 9 FOR REV.
E SEE SHEET 13 FOR REV.
F SEE SHEET 2 FOR REV.
G SEE SHEET 13 FOR REV.
H SEE SHEET 10 FOR REV.
J SEE SHEET 12 FOR REV.
U SEE SHEET 1 FOR REV
K IC201 CA3140AS WAS 741. R208 1K WAS 100Ω. C204 5uF. N.R 25V. WAS 1uF, 200V
BOARDS # 2 & 3
MODEL 360
TITLE: SCHEMATIC - REFERENCE INPUT CONDITIONING AND 1ST SQ. WAVE GENERATOR
IRD MECHANALYSIS, INC.
COLUMBUS, OHIO
DRAWING NUMBER D6-6233

Figure A-36 Schematic Diagram of Reference Input Conditioning and 1'st Square Wave Generator Circuits

LTR	REVISION	CHANGE ORDER	CK'D DATE	APP'D DATE
A	MISC. CHECKING CHANGES INCORP.	~	NWC 5-1-74	[illegible] 5-1-74
B	SEE SHEET #10	1366	NWC 7-5-74	[illegible] 7-5-74
C	MISC. REVISIONS	~	NWC 7-5-74	[illegible] 7-5-74
U	SEE SHEET 1 FOR REV.			



6. ⏚ CIRCUIT GROUND; ⏚ CHASSIS GROUND.
5. CAPACITOR VALUES ARE MFD UNLESS OTHERWISE NOTED.
4. INPUT IMPEDANCE OF MEASURING INSTRUMENTS SHALL BE ONE MEGOHM OR GREATER.
3. A.C. SIGNALS ARE SINE WAVES UNLESS SHOWN OTHERWISE. PEAK TO PEAK VOLTAGES SHOWN IN ( ).
2. FOR COMPONENT LOCATION ON ASM. 9604 BD #4 SEE DWG D2-5652, FOR ASM. 9605 BD #5 SEE DWG. D2-5637
1. A.C. VOLTAGES AND WAVE FORMS TAKEN IN "TEST" MODE WITH PHASE METER SET TO 90°

NOTES:

BOARDS 4 & 5

ITEM NO.	PART NO.	QTY REQ.	DRAWING NO.	DESCRIPTION / SPECIFICATION	VENDOR	VENDOR ASSEMBLY

TOLERANCES UNLESS SPECIFIED OTHERWISE

FRACTIONS ±1/64 | DECIMALS ± .005 | ANGLES ± 1/2°

SCALE: NOT TO SCALE

TITLE: SCHEMATIC - REF. FREQ. DOUBLER AND 2nd SQ. WAVE GENERATOR - MODEL 360

IRD MECHANALYSIS, INC. COLUMBUS, OHIO

D2-6233 B

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Figure A-37 Schematic Diagram of Reference Frequency Doubler and 2'nd Square Wave Generator Circuits

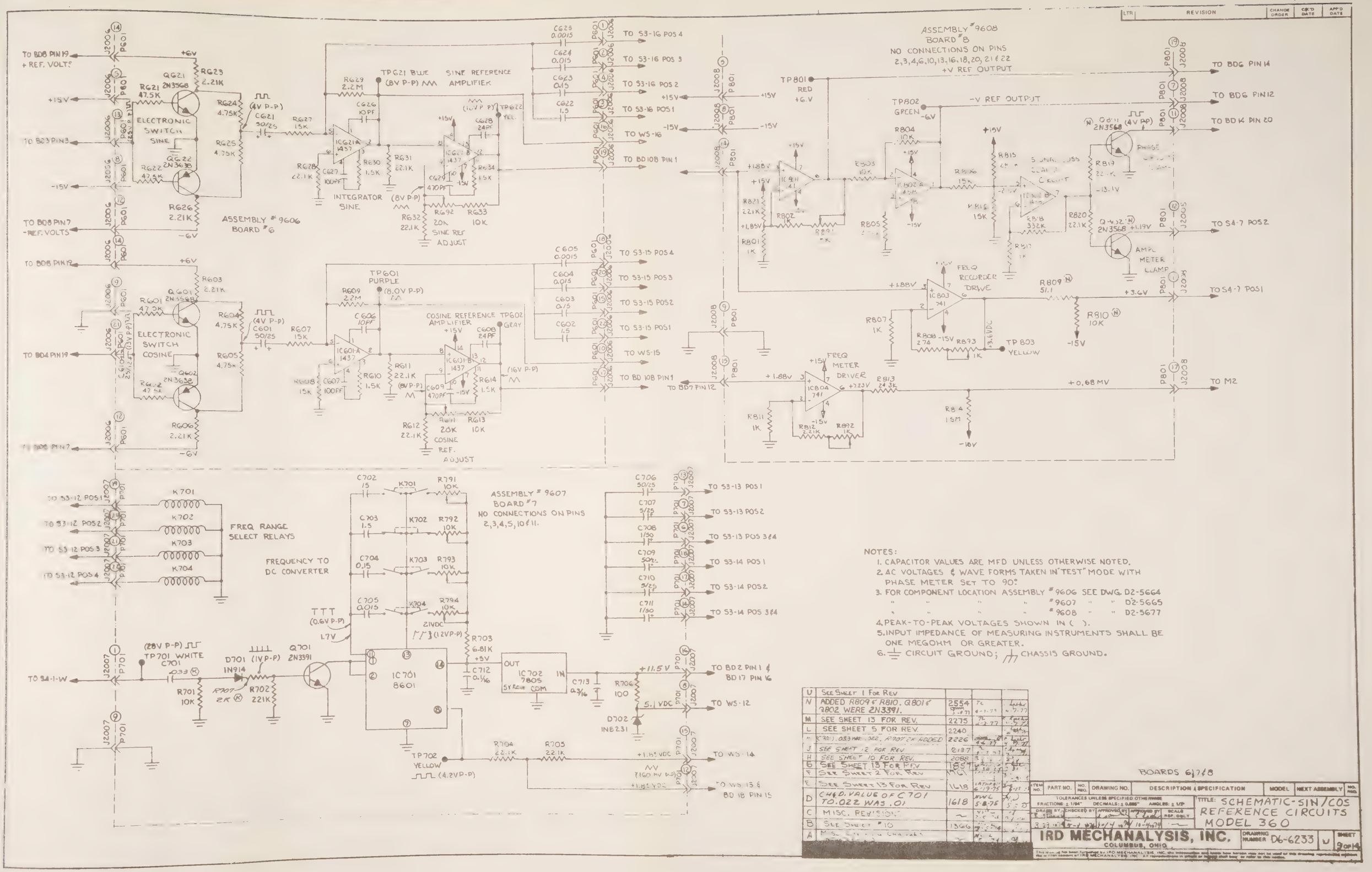
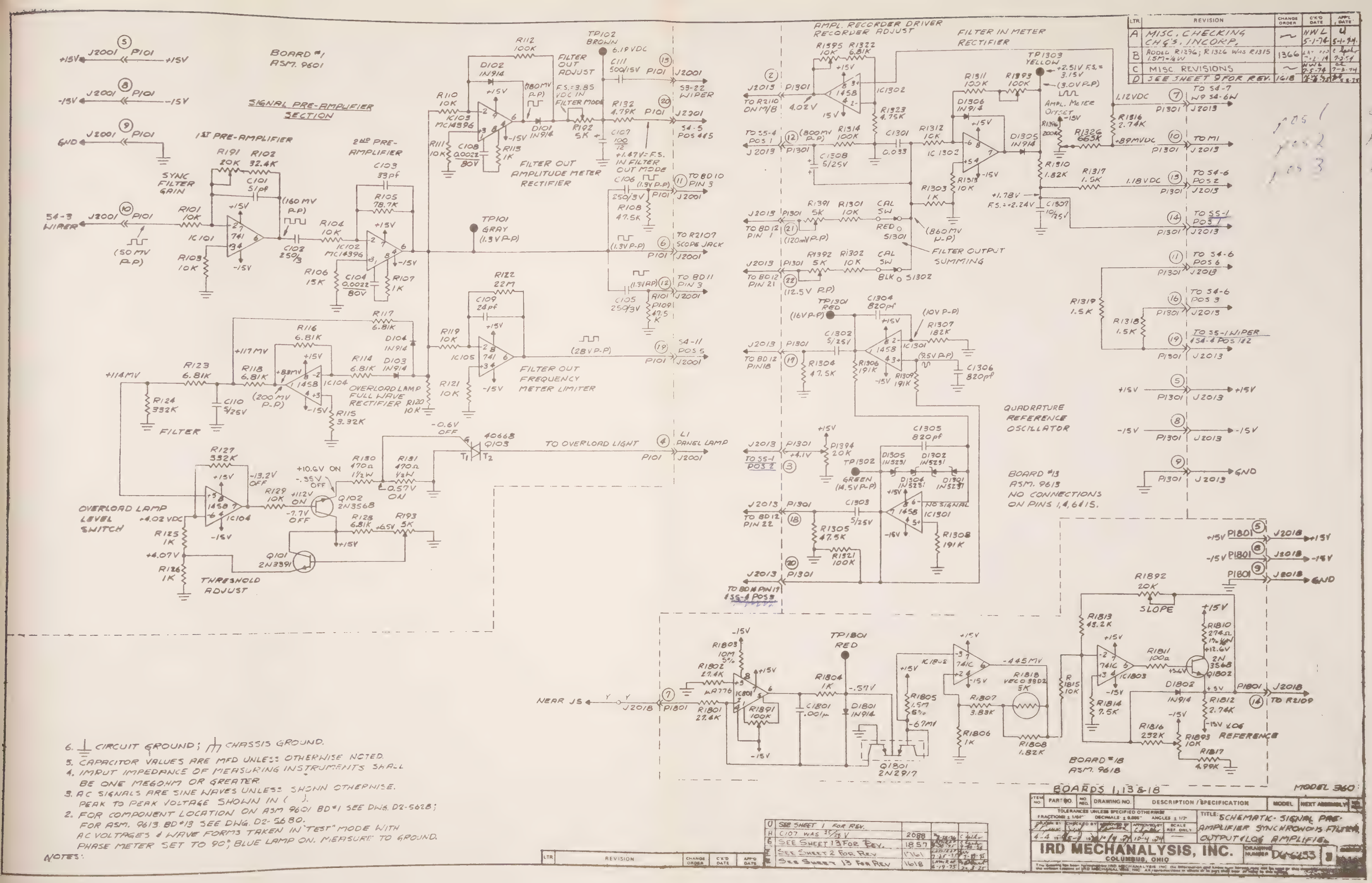

ASSEMBLY #9606 BOARD #6
ASSEMBLY #9607 BOARD #7
NO CONNECTIONS ON PINS 2,3,4,5,10 & 11.
ASSEMBLY #9608 BOARD #8
NO CONNECTIONS ON PINS 2,3,4,6,10,13,16,18,20,21 & 22
+V REF OUTPUT
-V REF OUTPUT
SINE REFERENCE AMPLIFIER
COSINE REFERENCE AMPLIFIER
ELECTRONIC SWITCH SINE
ELECTRONIC SWITCH COSINE
INTEGRATOR SINE
SINE REF ADJUST
COSINE REF. ADJUST
FREQ RECORDER DRIVE
FREQ METER DRIVER
SINE/COS CLAMP CIRCUIT
AMPL METER CLAMP
FREQ RANGE SELECT RELAYS
FREQUENCY TO DC CONVERTER
TTT
TP601 PURPLE
TP602 GRAY
TP801 RED +6.V
TP802 GREEN -6V
TP803 YELLOW
TP701 WHITE
TP702 YELLOW
TO S3-16 POS 4
TO S3-16 POS 3
TO S3-16 POS 2
TO S3-16 POS 1
TO WS-16
TO BD10B PIN 1
TO S3-15 POS 4
TO S3-15 POS 3
TO S3-15 POS 2
TO S3-15 POS 1
TO WS-15
TO BD 10B PIN 1
TO S3-13 POS 1
TO S3-13 POS 2
TO S3-13 POS 3&4
TO S3-14 POS 1
TO S3-14 POS 2
TO S3-14 POS 3&4
TO BD6 PIN 14
TO BD6 PIN 12
TO BD8 PIN 20
TO S4-7 POS 2
TO S4-7 POS 1
TO M2
TO WS-12
TO WS-14
TO WS-15 & BD 18 PIN 15
TO BD2 PIN 1 & BD 17 PIN 16
TO S4-1-W
TO BD8 PIN 19 +REF. VOLTS
TO BD8 PIN 7 -REF. VOLTS
TO BD8 PIN 12
TO BD4 PIN 19
TO BD3 PIN 3
TO BD7 PIN 12
+6V
+15V
-15V
-6V
+1.88V
+3.6V
+0.68 MV
+11.5 V
5. VDC
+1.85 VDC
+1.19V
-13.1V
-16V
+13.6VDC
(4V P-P)
(8V P-P)
(16V P-P)
(12VP-P)
(28V P-P)
(1VP-P)
(0.6V P-P)
1.7V
21VDC
(4.2VP-P)
NV (160 MV P-P)
IC 701 8601
IC 702 7805 5V REG COM
K701
K702
K703
K704
Q701 2N3391
IN914
IN6231
NOTES:
1. CAPACITOR VALUES ARE MFD UNLESS OTHERWISE NOTED.
2. AC VOLTAGES & WAVE FORMS TAKEN IN "TEST" MODE WITH PHASE METER SET TO 90°
3. FOR COMPONENT LOCATION ASSEMBLY #9606 SEE DWG. D2-5664
" " " " #9607 " " D2-5665
" " " " #9608 " " D2-5677
4. PEAK-TO-PEAK VOLTAGES SHOWN IN ( ).
5. INPUT IMPEDANCE OF MEASURING INSTRUMENTS SHALL BE ONE MEGOHM OR GREATER.
6. ⏚ CIRCUIT GROUND; ⏚ CHASSIS GROUND.
LTR REVISION CHANGE ORDER CK'D DATE APP'D DATE
U SEE SHEET 1 FOR REV 2554
N ADDED R809 & R810. Q801 & Q802 WERE 2N3391. 2554
M SEE SHEET 13 FOR REV. 2275
L SEE SHEET 5 FOR REV. 2240
K C701 .033 MFD, 200 V. R707 2K ADDED 2226
J SEE SHEET 12 FOR REV 2137
H SEE SHEET 10 FOR REV. 2088
G SEE SHEET 13 FOR REV 1857
F SEE SHEET 2 FOR REV
E SEE SHEET 13 FOR REV 1618
D C46 0. VALUE OF C701 TO .022 WAS .01 1618
C MISC. REVISION —
B SEE SHEET #10 1366
A
BOARDS 6,7 & 8
ITEM NO. PART NO. NO. REQ. DRAWING NO. DESCRIPTION & SPECIFICATION MODEL NEXT ASSEMBLY NO. REQ.
TOLERANCES UNLESS SPECIFIED OTHERWISE FRACTIONS ± 1/64" DECIMALS: ± 0.005" ANGLES: ± 1/2°
DRAWN BY CHECKED BY APPROVED BY APPROVED BY SCALE REF. ONLY
TITLE: SCHEMATIC-SIN/COS REFERENCE CIRCUITS MODEL 360
IRD MECHANALYSIS, INC. COLUMBUS, OHIO
DRAWING NUMBER D6-6233 U SHEET 9 OF 14

Figure A-38 Schematic Diagram of Sin/Cosine Reference Circuits



NOTES:

6. ⏚ CIRCUIT GROUND; ⏚ CHASSIS GROUND.
5. CAPACITOR VALUES ARE MFD UNLESS OTHERWISE NOTED.
4. IMPUT IMPEDANCE OF MEASURING INSTRUMENTS SHALL BE ONE MEGOHM OR GREATER.
3. AC SIGNALS ARE SINE WAVES UNLESS SHOWN OTHERWISE. PEAK TO PEAK VOLTAGE SHOWN IN ( ).
2. FOR COMPONENT LOCATION ON ASM 9601 BD #1 SEE DWG. D2-5628; FOR ASM. 9613. BD #13 SEE DWG. D2-5680.

LTR	REVISION	CHANGE ORDER	C'K'D DATE	APP'D DATE
A	MISC, CHECKING CHG'S, INCORP.	~	NWL 5-1-74	5-1-74
B	ADDED R1396; R1326 WAS R1315 1.5M-1/4W	1366	LAT 7-2-74	7-2-74
C	MISC. REVISIONS	~	NWL 7-5-74	7-3-74
D	SEE SHEET 9 FOR REV.	1618	7-8-75	7-9-75
E	SEE SHEET 1 FOR REV.	2088	7-16-76	7-16-76
F	C107 WAS 33/25V	1857	7-27-76	7-27-76
G	SEE SHEET 13 FOR REV.	1761	7-27-76	7-27-76
H	SEE SHEET 2 FOR REV.	1761	7-27-76	7-27-76
J	SEE SHEET 13 FOR REV	1618	5-19-75	7-8-75

Figure A-39 Schematic Diagram of Signal Preamplifier Synchronous Filter Output and Log Amplifier Circuits

LTR	REVISION	CHANGE ORDER	CK'L DATE	APPD DATE
A	MISC. CHECKING CHG'S. INCORP.	~	NWL 5-1-74	5-1-74
B	SEE SHEET #10	1366	NWL 7-2-74	7-3-74
C	MISC REVISIONS	~	NWL 2-3-76	2-3-76
D	SEE SHEET 9 FOR REV.	1618	NWL 5-18-75	5-19-75
E	SEE SHEET 13 FOR REV.	1618	5-18-75	6-1-75
F	SEE SHEET 2 FOR REV.	1761	9-15-75	9-9-75
G	SEE SHEET 13 FOR REV.	1857	12-12-75	12-22-75
H	SEE SHEET 10 FOR REV.	2088	2-24-76	2-25-76
J	SEE SHEET 12 FOR REV.	2197	7-7-77	7-8-77
K	SEE SHEET 9 FOR REV.	2226	7-7-77	7-8-77

BOARD #10 ASM. 9610A
COSINE CHANNEL
(SEE NOTE #1)

TP1002B RED
-11 MV (SEE NOTE #1)
(1.1 V P-P)

TP1002A RED
+388MV
(12 V P-P)

(F.S. = 700 MV RMS) (1.3 V P-P)

NO CONNECTIONS ON PINS 10, 11 & 21 BOARD 10

INPUT AMPLIFIER A/D 428K Z1001

SEE NOTE #1
P1008
(8 V P-P)

J2010A P1001A +15V
J2010A P1001A -15V
J2010A P1001A GND
J2010A P1001A NO CONNECTION
J2010A P1001A COSINE REF. OUTPUT BD. (16 V P-P) 6 PIN 17
J2011A P1001A TO BD I PIN II VIBRATION SIGNAL
J2010B P1001B TO SINE WAVE REF. OUT J2 (SEE NOTE #1)
J2011B P1001B SINE REF. OUTPUT BD 6 PIN 19. (SEE NOTE #1)

C1001 50/25V
R1001 8.25K
(8.8 V P-P)
D1001 IN747
D1002 IN747
D 1003 IN749
D 1004 IN749
D 1005 IN750
D 1006 IN750
R1002 40.2K
R 1003 27.4K
R 1005 68.1K
R1006 68.1K
REF. WAVE SYNTHESIZER
REF GAIN R1091 50K
R1007 47.5K
IC 1001 (CA3140)
R1004 47.5K
C 1002 50 25V
(16 V P-P)

TP1001B WHITE
(19.8 V P-P) (7 V RMS)
(SEE NOTE #1)
TP1001A WHITE
(19.8 V P-P)
(7 V RMS)

J2010B P1001B TO SINE WAVE REF. OUT J2 (SEE NOTE #1)

BOARD #10 ASM. 9610B
SIN CHANNEL
(SEE NOTE #1)

P1001B J2010B TO S3-3 POS 4 & S3-26 POS 4
P1001B J2010B TO S3-4 POS 4 & S3-23 POS 4
P1001B J2010B TO S3-3 POS 3
P1001B J2010B TO S3-4 POS 3
P1001B J2010B TO S3-3 POS 2
P1001B J2010B TO S3-4 POS 2
P1001B J2010B TO S4-8 POS 1
P1001B J2010B TO S4-9 POS 1
P1001B J2010B TO S4-8W
P1001B J2010B TO S4-9W

P1001A J2010 C1004 0.15 R1008 100K IC1004 1458 -15V
P1001A J2010 C1010 0.47 R1011 221K R1010 100K IC1002 1458 -15V
P1001A J2010 C1008 2 R1013 221K R1012 100K IC1003 1458 -15V
P1001A J2010 C1010 10 R1015 221K R1014 100K C1009 10 IC1002 1458 -15V
(4) 1ST LOW PASS FILTER STAGE

P1001A J2010 C1012 0.15 R1017 2.21K R1016 100K IC 1004 1458 -15V
P1001A J2010 C1014 0.47 R1019 2.21K R1018 100K IC1005 1458 -15V
P1001A J2010 C1016 2 R1021 221K R1020 100K IC 1005 1458 -15V
P1001A J2010 C1018 10 R1023 221K R1022 100K C1017 10 IC1005 1458 -15V
(4) 2ND LOW PASS FILTER STAGE

S3-1 S3-24 S3-25 S4-11 S4-10
TP1004A ORANGE +388MV
TP 1004B (RANGE 2.1 V)
J2010 P1001A TEST BAL
C1020 0.15 R1024 2.21K IC 1006 1458 -15V
BUFFER STAGE

J2010 P1001A +15V
J2012 P1201 -15V
J2012 P1201 GND
P1201 J2012 (13)
SEE NOTE #1
TP1003B YELLOW -30 MV
TP1003A YELLOW +342 MV
IC 1003 1458 +15V -15V
P1001A J2010A +14.2V
BUFFER STAGE

C1201 3
R1203 1.5K
R1291 1K
TP 1201 GREEN -8.1V
IC 1201 1458 +15V -15V
R1208 100Ω
COSINE CHANNEL D.C. AMP.
R 1201 100Ω
R1202 8.25K
P1201 J2012 (15)

BETWEEN +5V & -5V
R1204 5.11Ω
R1205 2.21K
R1293 20K
R1206 2.21K
R1207 5.11Ω
DI201 IN5231
DI202 IN 5231
C1205 100/25V
C1206 100/25V
R1294 20K
DC AMP NULLING CIRCUIT
BETWEEN +5V & -5V
R1210 8.25K
P1001B J2010B -15MV
P1201 R1209 100Ω
IC 1201 1458 +15V -15V
R1212 100Ω

A/D 432K Z1201
C1203 5/25V
P1201 J2012 (21) TO BD 13 PIN 21
(14.5 V P-P) P1201 J2012 (22) TO BD 13 PIN 18
COSINE OUTPUT MULTIPLIERS
C1204 5/25V
(120 MV P-P) P1201 J2012 (1) TO BD 13 PIN 22
(16 V P-P) P1201 J2012 (18) TO BD 13 PIN 17

C1202 5
R1211 1.5K
R1292 1K
TP1202 RED +287 MV
SINE CHANNEL D.C. AMP.

NO CONNECTIONS ON PINS 2, 3, 4, 6, 10, 11, 12, 14, 15, 16, 17, 19 & 20.

BOARD #12 ASM. 9612

7. ⏚ CIRCUIT GROUND; ⏚ CHASSIS GROUND.
6. CAPACITOR VALUES ARE MFD UNLESS OTHERWISE NOTED.
5. INPUT IMPEDANCE OF MEASURING INSTRUMENTS SHALL BE ONE MEGOHM OR GREATER.
4. A.C. SIGNALS ARE SINE WAVES UNLESS SHOWN OTHERWISE. PEAK TO PEAK VOLTAGES SHOWN IN ( ).
3. FOR COMPONENT LOCATION ON ASM. 9610A&B BD#10 SEE DWG. D2-5678, FOR ASM. 9612 BD#12 SEE DWG. D2-5679.
2. A.C. VOLTAGES AND WAVE FORMS TAKEN IN "TEST" MODE WITH PHASE METER SET TO 90°; BLUE LAMP ON. MEASURED TO GROUND.
1. ASM. #9610B SINE CHANNEL, SAME AS COSINE CHANNEL ASM #9610A.

NOTE 3:

BOARDS 10A, 10B & 12

LTR	REVISION	CHANGE ORDER	CK'L DATE	APPD DATE
D	SEE SHEET 1 FOR REV.			
P	CA3140 WAS 741	2489		
N	SEE SHEET 9 FOR REV.	2554	4-7-77	
M	SEE SHEET 13 FOR REV.	2279	4-7-77	
L	SEE SHEET 5 FOR REV.	2240	4-7-77	

ITEM NO.	PART NO.	NO REQ.	DRAWING NO.	DESCRIPTION / SPECIFICATION	MODEL	NEXT ASSEMBLY	NO. USED

TOLERANCES UNLESS SPECIFIED OTHERWISE: FRACTIONS ± 1/64" DECIMALS: ± 0.005" ANGLES: ± 1/2°

DRAWN BY | CHECKED BY | APPROVED BY | APPROVED BY | DEALE: REF. ONLY

TITLE: SCHEMATIC - SYNCHRONOUS FILTER MODEL 360

IRD MECHANALYSIS, INC.
COLUMBUS, OHIO

DRAWING NUMBER D6-6233 -10

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Figure A-40 Schematic Diagram of Synchronous Filter Circuits

LTR.	REVISION	CHANGE ORDER	CK'D. DATE	APP'D DATE
A	MISC. CHECKING CHG'S. INCORP.	~	WNL 5-7-74	5-1-74
B	SEE SHEET #10	1366	WNL 5-7-74	5-3-74
C	MISC. REVISIONS	~	WNL 5-7-74	5-3-74
D	SEE SHEET 9 FOR REV.	1619	WNL 3-25-75	3-26-75
E	SEE SHEET 13 FOR REV.	1618	LATHROP 6-19-75	6-19-75
F	SEE SHEET 2 FOR REV.	1760	LATHROP 7-25-75	7-29-75
G	SEE SHEET 13 FOR REV.	1857	LATHROP 2-26-76	3-8-76

NOTES.
1. VOLTAGES AND WAVFORMS TAKEN IN "TEST" MODE WITH PHASE METER SET TO 90°, BLUE LAMP ON. MEASURED TO GROUND.
2. FOR COMPONENT LOCATION ON ASSY. 9614, BOARD 14, SEE DWG. D2-5683; FOR ASS'Y. 9615, BOARD 15, SEE DWG. D2-5694.
3. AC SIGNALS ARE SINE WAVE UNLESS SHOWN OTHERWISE. PEAK TO PEAK VOLTAGE SHOWN IN ( ).
4. INPUT IMPEDANCE OF MEASURING INSTRUMENTS SHALL BE ONE MEGOHM OR GREATER.
5. CAPACITOR VALUES ARE MFD. UNLESS OTHERWISE NOTED.
6. ⏚ = CIRCUIT GROUND; ⏚ CHASSIS GROUND
7. BAL = BALANCE; FO/S = FILTER OUT/SPEED FO/F = FILTER OUT/FREQ. SA = SPECTRUM ANALYSIS.

U	SEE SHT 1 FOR REV			
R	D1402 THRU D1405 WERE IN4735 R1435 & R1437 WERE 215. R1422 WAS 10M	2555		
P	SEE SHEET 11 FOR REV.	2489		
N	SEE SHEET 9 FOR REV.	2554		
M	SEE SHEET 13 FOR REV.	2275		
L	SEE SHEET 5 FOR REV	2240		
K	SEE SHEET 9 FOR REV.	2276		
J	ADDED R1439 (R1495, D1410 & D1409 WAS INC 7A.	2137		
H	SEE SHEET 10 FOR REV.	2088		

BOARDS 14 & 15 PHASE CIRCUITS

ITEM NO.	PART NO.	NO. REQ.	DRAWING NO.	DESCRIPTION / SPECIFICATION	MODEL	NEXT ASSEMBLY

TOLERANCES UNLESS SPECIFIED OTHERWISE: FRACTIONS ± 1/64" DECIMALS ± 0.005" ANGLES ± 1/2°

DRAWN BY | CHECKED BY | APPROVED BY | APPROVED BY | SCALE REF. ONLY

TITLE: SCHEMATIC PHASE CIRCUITS MODEL 360

IRD MECHANALYSIS, INC. COLUMBUS, OHIO

DRAWING NUMBER D6-6235

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Figure A-41 Schematic Diagram of Phase Circuits

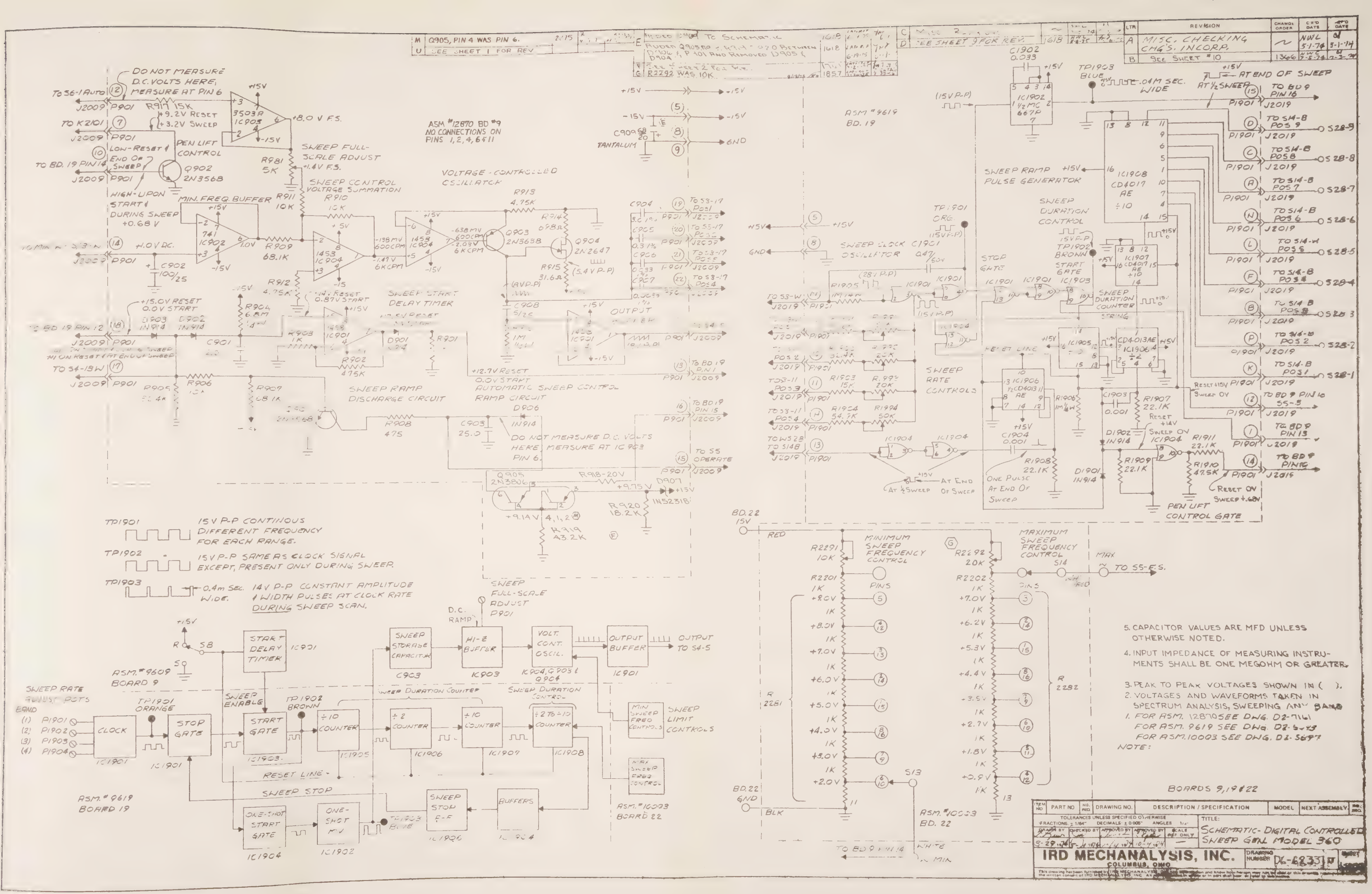
ASM #12870 BD #9
NO CONNECTIONS ON PINS 1,2,4,6&11
VOLTAGE-CONTROLLED OSCILLATOR
SWEEP RAMP DISCHARGE CIRCUIT
SWEEP START DELAY TIMER
AUTOMATIC SWEEP CONTROL RAMP CIRCUIT
SWEEP CLOCK OSCILLATOR
SWEEP DURATION COUNTER
SWEEP RATE CONTROLS
PEN LIFT CONTROL GATE
DO NOT MEASURE D.C. VOLTS HERE, MEASURE AT IC 903 PIN 6.
TP1901 15V P-P CONTINUOUS DIFFERENT FREQUENCY FOR EACH RANGE.
TP1902 15V P-P SAME AS CLOCK SIGNAL EXCEPT, PRESENT ONLY DURING SWEEP.
TP1903 0.4m Sec. WIDE. 14V P-P CONSTANT AMPLITUDE 1 WIDTH PULSES AT CLOCK RATE DURING SWEEP SCAN.
ASM.#9609 BOARD 9
ASM.#9619 BOARD 19
ASM.#10003 BOARD 22
BOARDS 9,19&22
CLOCK
STOP GATE
START GATE
÷10 COUNTER
÷2 COUNTER
÷276÷10 COUNTER
MIN SWEEP FREQ CONTROL
MAX SWEEP FREQ CONTROL
SWEEP LIMIT CONTROLS
RESET LINE
SWEEP STOP
ONE-SHOT START GATE
ONE-SHOT M.V.
SWEEP STOP F-F
BUFFERS
SWEEP STORAGE CAPACITOR
HI-Z BUFFER
VOLT. CONT. OSCIL.
OUTPUT BUFFER
MINIMUM SWEEP FREQUENCY CONTROL
MAXIMUM SWEEP FREQUENCY CONTROL
1. FOR ASM. 12870 SEE DWG. D2-7161
FOR ASM. 9619 SEE DWG. D2-5443
FOR ASM. 10003 SEE DWG. D2-5697
2. VOLTAGES AND WAVEFORMS TAKEN IN SPECTRUM ANALYSIS, SWEEPING ANY BAND
3. PEAK TO PEAK VOLTAGES SHOWN IN ( ).
4. INPUT IMPEDANCE OF MEASURING INSTRUMENTS SHALL BE ONE MEGOHM OR GREATER.
5. CAPACITOR VALUES ARE MFD UNLESS OTHERWISE NOTED.
IRD MECHANALYSIS, INC.
COLUMBUS, OHIO
SCHEMATIC-DIGITAL CONTROLLED SWEEP GEN. MODEL 360
DRAWING NUMBER D2-6833

Figure A-42 Schematic Diagram of Digital Controlled Sweep Generator Circuits

LTR	REVISION	CHANGE ORDER	CK'D DATE	APP'D DATE
A	MISC. CHECKING CI LTD, INCORP.	~	NWL 5-1-74	5-1-74
B	SEE SHEET #10	1366	[illegible] 7-E-74	[illegible]
C	MISC. REVISIONS	~	[illegible] 7-E-74	[illegible]
U	SEE SHEET 1 FOR REF.			

ASM NO. 9611, BOARD 17

JUMPERS — CAUTION: REMOVE 240V JUMPER

TB 1 2 3 4 5 6 7 8 — 117VAC

TERMINAL BOARD LOCATED ON REAR PANEL VIEWED FROM FRONT (REF. D2-4843)

FUSE F1 3AG-½ AMP

POWER SWITCH S-7: ON, LINE, OFF, LOAD, NEON

POWER INPUT RECEPTACLE 117VAC*

J9

C1 0.005 3KV

LOCATED ON FRONT PANEL

SIGNAL CONDITIONER POWER SUPPLY

LOCATED ON SIDE OF SIGNAL CONDITIONER

BLK/GRN — BLACK JUMPER — BLK/RED — WHITE JUMPER — BLK — WHT/BLK — WHITE — BLK/Y

* OPTIONAL 234 VAC LINE POWER

CAUTION: REMOVE TWO 117V JUMPERS

234 VAC — TO N/F ROCKER SWITCH — JUMPER

BLK/GRN — BLK/RED — BLK — BLK/Y

JUMPER

TB 1 2 3 4 5 6 7 8 — 234 VAC

SIGNAL CONDITIONER POWER SUPPLY

T1

GRN — J2017 P1701 — (19) — 10VAC 150MA WINDING — GRN — J2017 P1701 — (20) — FWL200 D1701 — R1701 1.5Ω 1½W — C1701 500/25 — TP1701 BLUE +11.5V (16) — P1701 J2017 — TO BOARD #2, PIN #14 BOARD #7, PIN #16 INPUTS OF +5V REGULATORS.

YEL — J2017 P1701 — (12) — 40VAC 10MA WINDING — YEL — J2017 P1701 — (11) — FWL200 D1702 — R1702 1K — R1703 1.2K — R1704 1.5K — C1702 50/150 — C1703 250/50 — C1704 0.1/80V — C1705 50/50 — Q1701 2N3VI — R1705 100K — R1706 43.2K — +40.4V — +7.9V — TP1702 RED +25V (15) — P1701 J2017 +25V

BRN — J2017 P1701 — (6) — 7 VAC 0.5MA WINDING — BRN — J2017 P1701 — (7) — FWL200 D1703 — R1707 0.47Ω 2W — +2.4V — C1706 1000/15 — R1708 1.5K — Q1702 DAC04 — +8.1V — R1709 10K — C1707 250/12 — +7.7V NO LOAD +4.5V LOADED — P1701 J2017 (22) — +5V FILTERED UNREGULATED TO PHOTO CELL UNIT — BLACK TP1704 — TP1703 BROWN — P1701 J2017 (8) (7) (10) GROUND

P1701 J2017 — (3) — TO PEN LIFT RELAY

T1 — TB — TO PANEL LAMPS

GRAY — 5.0VAC 480MA — GRAY — TB 1 — BLACK TB1-2 — GROUND — SHIELD BETWEEN PRI. & SEC. WDS. WHITE — BLACK

44 VAC CT 500 MA WINDING — RED — J2016 P1601 — (13) — RED — R/Y — R/Y J2016 P1601 — (18) (19) (20) — RED — J2016 P1601 — (14) — RED

D1601 FWL200 — C1603 500/50 — -28.3V — R1602 1.5Ω 1½W

BOARD #16 ASM #10501 BOARD #20-21

R2101 4.75K — (11.4V Pk-Pk) — REFERENCE TEST SIGNAL TO S4-5

IN5231 D2101 — R2102 47.5K — (43MV Pk-Pk) — TO S4-3 THEN 80#1. VIBRATION TEST SIGNAL — 500Ω R2101 — IN5231 D2102

BOARD #17 BOARD #16

+26.7V — R1601 1.5Ω 1½W — C1601 500/50 — +7.95V — R1603 1.21K — +7.34V — μA723C IC1601 — C1602 100pf — R1604 3.01K — R1601 500Ω — R1605 2.55K — TP1602 BLACK

+16.1V +15.4V — P1601 J2016 (16) (17) (21) (22) — +26.7V — +15V — Q2 MJE3055 — LOCATED ON REAR PANEL

R1609 4.12K — -7.62V — R1607 3.01K — -11.3V — R1608 3.01K — R1602 500Ω — R1610 1.21K — 11.3V — μA723C IC1602 — C1604 0.047 — C1605 100pf — R1611 2.2K — R1612 1Ω 2W — Q1601 — P1601 J2016 (15) (9) (8) (7) — -28.3V — -15.85V — -15.41V — -15V — TP1603 VIOLET — Q1 MJE2955 — LOCATED ON REAR PANEL

Q1 & Q2 — EMITTER — COLLECTOR — BASE — HEAT SINK CONTACT AREA BOTTOM

5. ▢ BARRIER STRIP TERMINAL.
4. ⏚ CIRCUIT GROUND; ⏚ CHASSIS GROUND.
3. CAPACITOR VALUES ARE MFD UNLESS OTHERWISE NOTED.
2. FOR COMPONENT LOCATION ASM. #9616, BOARD #16 SEE D2-5681; FOR ASM. #9617, BOARD #17 SEE D2-5682; FOR ASM #10501, BOARD #20/21 SEE D2-5740.
1. VOLTAGES MEASURED AT 117VAC LINE IN TEST MODE.

NOTES:

BD- BOARD
GRN- GREEN
BRN- BROWN
WHT- WHITE
BLK- BLACK
R/Y- RED/YELLOW

PRI- PRIMARY
SEC- SECONDARY
WDG- WINDING
R- RED
Y- YELLOW
S/N- SERIAL NUMBER
REF- REFERENCE
TB- TERMINAL BOARD

FOR BOARDS 16, 17 & 20/21

ITEM NO.	PART NO.	NO. REQ.	DRAWING NO.	DESCRIPTION / SPECIFICATION	MODEL	NEXT ASSEMBLY

TOLERANCES UNLESS SPECIFIED OTHERWISE: FRACTIONS ± 1/64" DECIMALS: ± 0.005" ANGLES ± 1/2°

DRAWN BY [illegible] CHECKED BY [illegible] APPROVED BY [illegible] SCALE REF. ONLY

TITLE: SCHEMATIC MODEL 360 POWER SUPPLY

IRD MECHANALYSIS, INC. — DRAWING NUMBER D2-6238

This drawing has information CONFIDENTIAL ONLY

Figure A-43 Schematic Diagram of Power Supply Circuits